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CONTENTS

Volume XIX, Number 1 January 1981

EDUCATION FOR ALL?

EDUCATION AND DEVELOPMENT 3
World Bank Staff

THE USE OF BROADCASTING IN PRIMARY SCHOOL CLASSROOMS 14
Robert Hornik, Barbara Searle, Dennis Foote and Jeanne Moulton

A RURAL ALTERNATIVE TO PRIMARY SCHOOLS IN UPPER VOLTA 25
Institut d'Etude du Developpement Economique et Social (IEDES)

CASE STUDIES IN PRIMARY EDUCATION 38
Judith Brace and Barbara O'Grady

ORGANIZATION FOR DEVELOPMENT

TOWARD A TECHNOLOGY FOR MANAGING SOCIAL DEVELOPMENT 45
David C. Korten

THE TRANSFERABILITY OF WESTERN MANGEMENT CONCEPTS--A FOURTH WORLD PERSPECTIVE 56
Jon R. Moris

A "NEGOTIATING MODEL" IN INTEGRATED RURAL DEVELOPMENT PROJECTS 66
Eric J. Miller

COMMUNITY HEALTH WORKERS

THE ROLE OF THE COMMUNITY HEALTH WORKER IN PRIMARY HEALTH CARE 79
World Bank Staff

COMMUNITY HEALTH WORKERS (continued)

THE VILLAGE HEALTH WORKER PROGRAM IN AFGHANISTAN 83
Steven L. Solter and Peter N. Cross

TRADITIONAL MEDICINE IN EAST AFRICA: THE SEARCH FOR A SYNTHESIS 98
Norman N. Miller

A MODEL FOR COMMUNITY HEALTH CARE IN RURAL JAVA 107
Lukas Hendrata

TRADITIONAL MIDWIVES: CONTROVERSIAL COMMUNITY HEALTH WORKERS 115
Mayling Simpson-Hebert, Phyllis T. Piotrow, Linda J. Christie and Janelle Streich

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EDUCATION FOR ALL?

PRIMARY EDUCATION IN THE THIRD
WORLD. TOP OF THE PAGE: PRIMARY SCHOOL STUDENTS
IN TOGO, WEST AFRICA. (PHOTO: ILO)
LOWER LEFT: A VILLAGE SCHOOL IN AFGHANISTAN
(PHOTO: UNITED NATIONS)
LOWER RIGHT: A RURAL CLASSROOM IN
CHILE. (PHOTO: U.S.I.S. CHILE)

Education and Development

World Bank Staff

[Experience of the past decade has indicated the value of education for development, and especially primary education. Some of the problems of extending education to the poor are discussed.]

Every individual is born with a collection of abilities and talents. Education, in its many forms, has the potential to help fulfill and apply them. In some societies the economic function of schooling is regarded as minor--since the cultivation of the mind and the spirit, curiosity, contemplation and reasoning have more than economic purposes and justifications. But in the context of this article, it is the role of education in overcoming poverty--increasing incomes, improving health and nutrition, reducing family size--that receives most attention.

A decade or two ago, there was a widespread view that trained people were the key to development. Universal literacy was a political objective in many countries, but money spent on primary schooling was often regarded as diverted from activities that would have contributed more to economic growth. Planners favored the kinds of secondary and higher education that directly met the "manpower requirements" of the modern sector. People who worked with their hands were thought not to have much need of formal education.

Over the past decade, views have changed substantially. Adequate provision of secondary and higher

This is an extract from the World Development Report, 1980 prepared by a team led by Paul Isenman and comprising Nicholas Hope, Timothy King, Peter Knight, Akbar Noman, Rupert Pennant-Rea and Adrian Wood of the World Bank.

education and training remains an important priority. But the value of general education at the primary level is now more widely recognized. We now consider some of the evidence that lies behind this change in views, and its implications for development strategy.

Recent progress. The major educational progress of the past two decades reflects heavy investment by developing countries. Their total public expenditure on education rose in real terms (in 1976 dollars) from about $9 billion in 1960 (2.4 percent of their collective GNP) to $38 billion in 1976 (4.0 percent of GNP). Costs per student vary widely by region--and by type of education (see Table 1). The potential for continued enrollment growth at different levels will, of course, be strongly affected by these costs.

Table 1

PUBLIC EXPENDITURES PER STUDENT ON ELEMENTARY AND HIGHER EDUCATION, 1976
(U.S. Dollars)

Region	*Higher (post-secondary) education*	*Elementary education*	*Ratio of higher to elementary education*
Sub-Saharan Africa	3,819	38	100.5
South Asia	117	13	9.0
East Asia	471	54	8.7
Middle East and North Africa	3,106	181	17.2
Latin America and Caribbean	733	91	8.1
Industrialized	2,278	1,157	2.0
USSR and Eastern Europe	957	539	1.8

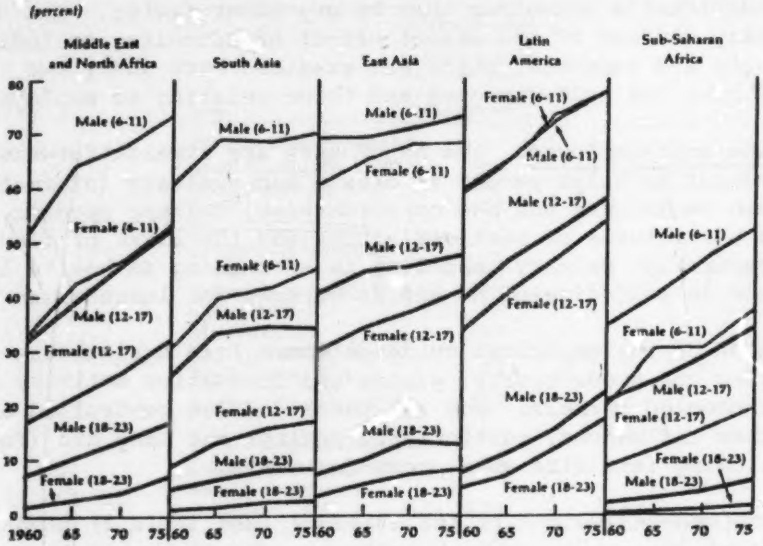
Note: Figures shown are averages (weighted by enrollment) of costs (in 1976 dollars) in the countries in each region for which data were available.

But school attendance in some parts of the world remains low, especially among the poor, in rural areas, and by girls (see Figure 1). This is not simply because schools are unavailable--not everyone who has an opportunity for education accepts it. Moreover. among those who do enroll in developing countries, an average of 40 percent drop out before the fourth year. In Brazil's poor rural Northeast region in 1974, despite an enrollment rate of 46 percent (less than half the national urban average), nearly two-thirds of the students dropped out before the second year--and it is estimated that at most 4 percent completed four years. And the completion statistics conceal the very low quality of some of the schooling provided.

Nonetheless, the very substantial growth in enrollment (Figure 1) is a sign of great educational advance. There are several mechanisms through which this has contributed to growth in incomes.

Figure 1

ENROLLMENT RATIOS, BY REGION, 1960-75



Source: UNESCO.

Effects of Education on Earning Power

Schooling imparts specific knowledge and develops general reasoning skills (its "cognitive" effects); it also induces changes in beliefs and values, and in attitudes toward work and society ("noncognitive" effects). The relative importance of these is much debated, and poorly understood; both are extremely important.

In the cognitive area, developing a generalized capacity for thinking and learning has been found to be more important than the specific subjects learned. On-the-job training, informal education and vocational training all build on learning abilities acquired earlier. Although literacy and numeracy deteriorate if left unused, the educational experience still generally provides an improved foundation for subsequent learning.

Many of the noncognitive effects of schooling--receptivity to new ideas, competitiveness, and willingness to accept discipline--are directly relevant to productive economic activity. Others--tolerance, self-confidence, social and civic responsibility--are more personal or political in nature, but may also affect individual economic performance.

Some of the evidence on the effects of education rests on attempts to measure attitudes directly. Studies in several countries have shown that "modernity" of outlook toward activities ranging from voting to family planning, saving, and working is more influenced by the level of the individual's schooling than by any other factor. But there are also many studies of the direct effect of schooling on individual productivity and earnings, which are examined here under two heads--those relating to the self-employed and those relating to employees.

The self-employed. The hypotheses are straightforward: that primary education helps people to obtain and evaluate information about improved techniques and new opportunities, to keep records, and to estimate the returns of past activities and the risks of future ones. More generally, primary schooling is a training in how to learn, an experience in self-discipline and in working for longer-term goals.

Most of the empirical evidence comes from agriculture--studies comparing the productivity, yields and innovative activity of schooled and unschooled farmers. Not all these studies controlled adequately for other influences, particularly wealth; but many did (for example, by including farm size as a proxy for wealth).

The general weight of the evidence (see Table 2) lends strong and consistent support to these hypotheses--and is particularly compelling because the studies measure productivity directly, not through wages. Where the complementary inputs required for improved farming techniques were available, the annual output of a farmer who had completed four years of primary schooling was on average 13.2 percent more than one who had not been to school. As expected, where complementary inputs were not available, the increase in output resulting from additional schooling was on average smaller--but still substantial.

Whether these increases should be regarded as large or small depends on the cost of achieving them. It is thus significant that studies that went on to compare the increase in production resulting from education with the costs of that education (for example, in Korea, Malaysia and Thailand) found rates of return on primary education comparing very favorably with investment in other sectors. It is, of course, impossible to predict which areas will offer scope for improved farming techniques in 10 years' time, when children leave school. In some, effects on farm productivity may be low. But given past progress in agricultural research, it is probable that some places with stagnant technology now will offer greatly improved possibilities. Thus, on growth as well as equity grounds, it would be short-sighted to leave a large part of the next generation of farmers illiterate.

Table 2

FARMER EDUCATION AND FARMER PRODUCTIVITY

Study	*Estimated percentage increase in annual farm output due to four years of primary education rather than none*
With complementary inputs[a]	
Brazil (Garibaldi), 1970	18.4
Brazil (Resende), 1969	4.0
Brazil (Taquari), 1970	22.1
Brazil (Vicosa), 1969	9.3
Colombia (Chinchina), 1969	–0.8
Colombia (Espinal), 1969	24.4
Kenya, 1971–72	6.9
Malaysia, 1973	20.4
Nepal (wheat), 1968–69	20.4
South Korea, 1973	9.1
Average (unweighted)	13.2
Without complementary inputs	
Brazil (Candelaria), 1970	10.8
Brazil (Conceicao de Castelo), 1969	–3.6
Brazil (Guarani), 1970	6.0
Brazil (Paracatu), 1969	–7.2
Colombia (Malaga), 1969	12.4
Colombia (Moniquira), 1969	12.5
Greece, 1963	25.9
Average (unweighted)	8.1
No information on availability of complementary inputs	
Average of eight studies (unweighted)	6.3

a. Improved seeds, irrigation, transport to markets and so on.

Employees. The second type of study relates the educational levels of individuals to their wages and salaries. If education affects the capacity to learn, innovate and adapt, its effects should be particularly important for employees doing nonroutine or changing tasks. For employees in modern enterprises, primary education also promotes disciplined work habits and responsiveness to further training, as well as offering the advantages of literacy and numeracy.

Studies of the rate of return to education for wage-earners deal mainly with relatively large urban enterprises; but a few have included small businesses and agricultural workers. All find that more schooling leads to higher earnings. And when the extra earnings resulting from primary education are weighed against its costs, high rates of return are consistently found. Similar studies for secondary and higher education find lower, though nonetheless substantial, returns (see Table 3).

Table 3

RATES OF RETURN TO EDUCATION
(Percentages)

Country group	*Primary*	*Secondary*	*Higher*	*Number of countries*
All developing countries	24.2	15.4	12.3	30
Low income/adult literacy rate under 50 percent[a]	27.3	17.2	12.1	11
Middle income/adult literacy rate over 50 percent	22.2	14.3	12.4	19
Industrialized countries	..	10.0	9.1	14

Note: In all cases, the figures are "social" rates of return: the costs include forgone earnings (what the students could have earned had they not been in school) as well as both public and private outlays; the benefits are measured by income before tax. (The "private" returns to individuals exclude public costs and taxes, and are usually larger.) The studies refer to various years between 1957 and 1978, mainly in the latter half of the period.

a. In this sample of 30 developing countries, those countries with low incomes also had literacy rates below 50 percent (at the time the studies were done). All the middle-income countries had literacy rates above 50 percent.

Investment Priorities in Education

Primary education is of particular importance in overcoming absolute poverty. But secondary and higher education and training also have major roles to play. [Note: The original report also covers vocational and nonformal education which are omitted here.]

Primary education. In countries where it is far from universal, the case for increasing the proportion of children who complete primary education is strong. There have been high economic returns in the past. It has been suggested, however, that the rate of return to primary schooling (especially in certain jobs) may decline as the proportion of the labor force with primary education increases. But this may be offset by shifts in the pattern of production toward more skill-intensive goods. In Table 3 the rates of return to primary education in countries with adult literacy rates above 50 percent, while somewhat below those in countries with adult literacy below 50 percent, are still strikingly high. And in the few countries where studies have been done at different periods, rates of return have usually declined, but only mildly.

There are also favorable effects on equity. As primary education becomes more widespread, the additional spending will be increasingly concentrated on backward rural areas, girls, and the poorest urban boys. In general, primary education tends to be redistributive toward the poor (see Table 4). In contrast, public expenditure on secondary and higher education tends to redistribute income from poor to rich, since children of poor parents have comparatively little opportunity to benefit from it.

Table 4

PUBLIC EDUCATION SPENDING PER HOUSEHOLD, BY INCOME GROUP (U.S. Dollars)

	Malaysia, 1974[b]		*Colombia, 1974*[c]	
Income group[a]	*Primary*	*Postsecondary*	*Primary*	*University*
Poorest 20 percent	135	4	48	1
Richest 20 percent	45	63	9	46

a. Households ranked by income per person.
b. Federal costs per household.
c. Subsidies per household.

Primary education of girls has favorable effects on the next generation:

In health. Studies in Bangladesh, Kenya and Colombia show that children are less likely to die the more educated their mothers, even allowing for differences in family income.

In nutrition. Among households surveyed in Sao Paulo, Brazil, for any given income level families were better fed the higher the mother's education.

In fertility. Education delays marriage for women, partly by increasing their chances for paid employment; and educated women are more likely to know about, and use, contraceptives.

Finally, it enriches peoples' lives. Many would regard this as sufficient justification for universal primary education, independent of its other benefits.

Secondary and Higher Education

Renewed emphasis on the importance of primary education, and on its high returns relative to secondary and higher education, should not start the pendulum swinging too far in the other direction. High levels of knowledge are necessary for many people who serve the poor, both directly as teachers, health workers and agricultural extension workers, and indirectly as researchers, technicians, managers and administrators. While their skills must be developed to a considerable extent through practical experience and in other ways, there is for some purposes no better or cheaper substitute for the formal disciplines of conventional schooling. Even allowing for doubts about the estimated rates of return to secondary and higher education, and for the existence of some educated unemployment, there are unquestionably severe shortages of skilled people in many developing countries.

More economical ways of producing skilled people need to be found however. Greater reliance on in-career and on-the-job training should be considered, and steps should be taken to reduce the high unit costs of secondary and higher education.

These steps can include reduction in the number of specializations that any one university offers, while there is greater planned differentiation in the specialties offered by universities in a nation, or group of nations. Correspondence courses are another means for decreasing higher educational expenditures. Studies in Kenya, Brazil, South Korea and the Dominican Republic indicate that such courses can effectively teach people in remote areas. Finally, because most post-primary students are from families in a higher than average income bracket, considerably more of the cost could be charged to parents who can pay the charges, while scholarship programs go to students who cannot afford to pay.

The present low cost of secondary and higher education makes it inevitable that in most countries demand for places will exceed supply for the foreseeable future, although some countries, such as South Korea, already have very high enrollment rates. But economic considerations are not the only relevant ones: secondary education often helps in lowering fertility and reducing child mortality (over and above the effects of primary education). All developed countries have found universal free secondary education to be desirable in its own right. The question for developing countries is less "whether" than "when." Higher education clearly also has scientific, cultural and intellectual objectives, as well as economic ones.

Implementing Education for the Poor

The education received by poor children depends on three things. The first is accessibility--are there school places for them within a reasonable distance from home? The second is use--do their parents send them to school, and are they allowed or encouraged to drop out? The third concerns the quality of the education that schools provide.

Accessibility. Financing constraints will often be compounded by difficulties in reaching the poor--distance, low-density populations and poor communications--so that building schools and supplying books, equipment and qualified teachers is a difficult and expensive task. For example, the Nepalese government estimates that it costs more than twice as much to build and equip a school in mountainous regions as it does in the plains; and attracting qualified teachers to remote areas has proved to be extremely difficult.

There is often much that can be accomplished by administrative action with relatively little capital investment. Repetition of classes and early dropout may be the result of excessively high promotion standards. In these circumstances, the flow of students can be accelerated by more automatic promotion--while maintaining quality by correcting some of the causes of repetition or dropout. In many situations resources can be freed for extending education by raising student-teacher ratios, which are the main determinant of unit costs (given teacher salaries) and are largely determined by class size. Extensive research shows that class size has surprisingly little effect on learning. For example, reducing an elementary-school class from 40 pupils to 15 can be expected to improve average achievement (in a standard test) by only about 5 percentage points. While there may be practical limits to increasing classes much above 50, the research does suggest that, for classes initially below 50, little will be lost if they are increased. It is important to maximize the use of available facilities--by rotating classes, with staggered scheduling and double shifts in areas of high population density. If there are not enough pupils within an acceptable distance from school to fill individual classes, student-teacher ratios and the use of space can be significantly improved by taking new students only in alternate years (as has been done successfully in a project financed by the World Bank in Malaysia) and by teaching more than one grade in a class, as in another World Bank-financed project in El Salvador.

Use. Since most poor parents believe that education would benefit their children--in terms of status and the ability to stand up to officials and merchants, as well as in their incomes--they must have reasons for not sending their children to school where they have the chance. They may question whether they will benefit themselves; they may even regard the school as a threat to their parental authority or traditional way of life; or they may simply believe that social or ethnic barriers are too great, or the quality of the available schooling too low, to make education worth its costs. For poor families, the help of children at home--in animal care, fetching fuel and water, taking care of young children while adults work, and in agricultural work during busy seasons--may conflict with a fixed school schedule. For some families, malnutrition and poor health of children may lead to poor attendance, inattention while in school, repetition of grades and, eventually, dropping out. And there are particular reasons that girls receive less education than boys. Since the mere existence of a school does not automatically mean it is used by all those eligible to attend, special measures may be needed to ensure that the education offered is attractive to the families for whom it is intended.

Changes in school scheduling is one measure. A school calendar may compete unnecessarily with the crop cycle, with important exams held at times when students are most needed by their parents in the fields. Reducing expenditures to the families of poorer students is another measure. Providing free textbooks and uniforms, if required, will reduce the direct costs of school attendance. A further measure is providing information about education so beneficiaries know what to expect. Beyond information and persuasion, compulsory primary education is not uncommon. Using mandatory education laws is sometimes regarded as more unfairly coercive than, say, manipulating costs, since it allows no parental choice at all. However, others argue that compulsory schooling should be viewed more as protecting the rights of children than restricting those of the parents.

Quality of education. This is generally low in developing countries, and has been found (for example, in studies undertaken in Thailand, Malaysia and the Philippines) to be lower still for poor and rural pupils. Poor quality public schools may lead the well-to-do to choose private schools for their children, reinforcing social and economic inequality.

Casual observation and small-scale studies have long suggested that poor training of teachers, lack of textbooks, and inadequate school facilities lead to poor educational results and provide a weak basis for subsequent training. But broad-based evidence to demonstrate the extent of the resulting learning losses has only recently become available--from a large research project, the International Evaluation of Educational Achievement; only four developing countries (Chile, India, Iran and Thailand) were among the 19 countries covered.

While international comparisons of student achievement must be approached gingerly, particularly when different languages or testing styles can affect the results, a clear pattern nonetheless emerges from the study. Differences in average performance of students from the 15 developed countries varied somewhat from subject to subject and country to country; but the differences by and large were small. The developing countries, however, did far less well--in all subjects tested, and at each of the three age levels examined. A typical finding showed the mean score for students in a developing country to be in the bottom 5 to 10 percent of students from a developed country. Some of the handicaps of children in developing countries may be due to lower levels of parental education (which has a substantial impact, particularly in the preschool years) or in some cases to prolonged malnutrition. But the evidence suggests that they are mainly a reflection of low-quality schooling.

There are a number of promising approaches to improving educational quality in developing countries:

- The curriculum should take into account the linguistic and home backgrounds of students. Materials which are inappropriate only exacerbate tendencies to repeat classes or drop out, particularly for those from poor homes. Whenever possible, subjects should be illustrated with examples that draw on the child's experience.

- The selection and training of teachers should be improved through more training facilities, greater use of in-service training, and more teachers' guides, advisory services, mass-media programs and bulletins. This takes more resources as well as time, however.

- The design, production and distribution of learning materials should be upgraded. This applies particularly to textbooks, because research indicates that increasing their numbers and availability is the most consistently effective way of raising educational standards. A nationwide textbook project supported by the World Bank in the Philippines significantly increased student learning while increasing costs per student by only 1 percent. When school budgets are squeezed, it is all too easy to cut or defer spending on learning materials. But this is a costly alternative if costs are considered in terms of the education provided rather than simply the expenditures per student in school.

- Properly designed and supported radio projects have potential for improving learning (and in certain cases reducing costs). To take a well-documented example, in Nicaragua regular radio broadcasts achieved dramatic improvements in mathematics for primary students.

Research into these approaches has indicated important potential, but it remains to be seen how much they can improve quality within the constraints of politically feasible budgets. This underlines the importance of finding cheap ways to improve quality if the educational gaps between rich and poor are to be narrowed.

[Extracted from World Development Report 1980, pp. 46-53. New York: Oxford University Press for the World Bank, 1980. Copyright© The International Bank for Reconstruction and Development, Washington, D.C.]

Note: The World Development Report, 1980 is available without charge from the World Bank in Spanish; it may be purchased in French from: Editions Economica, 49, rue Hericart, 75015 Paris, France.

The Use of Broadcasting in Primary School Classrooms

Robert Hornik, Barbara Searle, Dennis Foote
and Jeanne Moulton

[The access to primary schooling in Third World countries is often hindered by too few schools and teachers, especially in remote areas, and the quality of education received may be limited. Broadcasting in the form of educational radio or television holds promise as a means of countering these obstacles to success in universal primary education.]

Universal primary schooling has become a goal of most developing countries, but in 1970 only about 35% of the school-age children in the world's poorest countries were in school. There are wide differences among developing nations in the proportion of children reached by the primary-school system, and wide differences in the quality of the education they receive, but there is sufficient commonality in the problems of primary school and the attempts being made to solve them to warrant discussion at a general level.

Access to Schooling

The problem of access has two important aspects: the availability of places in school for those who want to come; and the desire for schooling among those who are eligible and for whom there are places. At present, most developing countries cannot support a primary-school system that meets the demand, thus masking the second aspect.

School shortages are more severe in rural than urban areas, and it is difficult to staff even existing

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rural schools adequately. In most countries both the living and working conditions in rural areas are relatively backward and teachers are reluctant to work there. Even teachers who have come from the countryside have often been "spoiled" by their stay in urban areas for training. Further, both repetition by pupils of the same grade and dropping out during the school year result in inefficient use of school places, and therefore aggravate access problems. Dropping out during the school year contributes to underutilization of existing school facilities because places taken at the beginning of the year by students who later drop out are unavailable to others who might remain for the entire year. Students who repeat also occupy places that could be used by others. The repetition problem is likely to be most severe at two levels: the first grade, and the highest grade taught in the school. Repeaters in first grade occupy seats that could be used by new entrants. At the top grade are students who want more schooling but have no secondary school they can go to. Data from El Salvador, for example, suggest that about 50% of the repeaters in rural primary schools had passed the previous grade, and in order to stay in school after completing the highest grade must apparently return to the grade level they have already passed.

The traditional solutions to the access problem are to build more schools and train more teachers. But education budgets are limited, so an essential problem in increasing access is to find ways to expand opportunities for schooling without increasing budgets. One set of solutions would use school facilities and teacher time more efficiently. Running double shifts (of a reduced number of hours) in schools extends the availability of classrooms, and permits more students to be reached by a teacher in a given number of teaching hours. The El Salvador sector analysis by B. Robinson (1977) reports that "in both the rural and urban zones half-day students had overall about the same performance on national achievement exams as the whole day students," which seems a surprising finding but certainly supports the use of double sessions. However, double-shifting may not be a practical solution in sparsely populated areas where demand may not justify more than one class at a grade level. Using community buildings as schools (when not needed) also reduces the need for new buildings, but does not change the requirement for teachers.

Increasing class size economizes on both classrooms and teachers, but the rooms must be large enough to accomodate more students. It may also make the teachers' task more difficult, although evidence on the relation between class size and school outcome variables is equivocal. The cost for teachers (per student) can also be reduced by using monitors, aides, or community members who work under the supervision of a teacher, enabling the latter to be responsible for many more children than he or she could teach personally. With the exception of the last, all of these proposed solutions are more suitable for the expansion of an existing school to accommodate more students than for the provision of schooling opportunities in places where no such opportunities currently exist. All of these access-improvement strategies are likely to make the improvement of the quality of instruction more difficult.

Radio and television broadcasting have been used to attack the access problem in two ways--directly, through the provision of an alternative instructional mechanism; and indirectly, through the maintenance or improvement of quality when one or more of the institutional solutions (double-shifting, increasing class size, employing less well-trained teachers) is implemented. The Radioprimaria program in Mexico provides an example of direct use of mass media to extend primary schools to unserved audiences.

Radioprimaria functions in primary schools and aims to extend schooling within the school setting. The problem Mexico faces is typical: The Mexican Constitution of 1917 promises a primary education to everyone, but in 1973 only 6,500 of the 32,900 primary schools in the country had all six grades. The goal of Radioprimaria, begun in 1970, is to provide instruction at the upper primary grade levels in schools that lack teachers for these grades. The students were supervised, but not taught, by the teacher of another grade level. The hope was to provide adequate education without incurring the cost of an additional teacher. Studies done in the early stages of the Radioprimaria project found that the radio students competed successfully with students in conventional classrooms on achievement tests. P. Spain's study of Radioprimaria in 1977 identified many difficulties with its implementation. He visited radio schools and found fewer than half of them actually using the radio on the day of the visit. Reception was poor, the lessons were difficult to understand and were paced too fast, and some teachers did not think they were useful. Furthermore, many of the schools using radio had six grades and therefore did not qualify as target schools for the program. Spain concluded that while the low level of supervision--essentially none at all--was hindering the success of the program, children were nevertheless able to learn from it.

The Radioprimaria project has remained experimental and is confined to one small area of central Mexico; at present lessons are broadcast only for fifth graders. According to Spain, administrators recognize the need for adequate supervision, and since they lack funds for this function have not expanded the program. Some other difficulties have been corrected. A stronger transmitter allows better reception. Radio programs have been revised so that students participate more in the lessons, and the material is less abstract. However, the Radioprimaria experience indicates that technical difficulties such as maintaining the radios in working condition and lack of supervision may cause the failure of an otherwise promising program.

The radio schools of Australia, which have been in operation since 1933, provide another example of using radio to extend primary schooling. The program uses two-way radio to provide contact between the instructor and children whose homes are in remote areas of the country. The school lessons are based primarily on correspondence instruction; the radio is used to decrease the sense of isolation of the children and to provide motivation for studying. Although highly successful, this program may not be easily replicable: the two-way network was in place in Australia for other purposes, and its use by students did not represent a large add-on cost. To create such a network for the sole use of schools would take a large and rarely feasible investment.

Quality of Schooling

On the average, schooling in developing countries is of poorer quality than schooling in the developed countries. This contention is supported by the results of the massive International Evaluation of Educational Achievement (IEA) study designed to make cross-national comparisons of achievement in standard school subjects. Our intention here is not to defend the IEA study. One could argue, for example, that the examinations given for the study were inappropriate for developing countries; however, the IEA conclusions are not likely to be disputed by those with experience in the developing world. Low achievement levels are recognized, but we know rather little about the causes. We can, however, propose some explanatory hypotheses.

The quality problem can be examined along three dimensions: what the children bring to school, what the teacher brings to school, and the nature of the classroom itself. The importance of home background as a determinant of success in school has been well established for developed countries and, although not as thoroughly documented, in developing countries (LDCs) as well. Typical LDC children lack many of the cultural supports, such as books in the home, that have been associated with school success in the developed world. Although students may well enjoy a rich cultural life, the character of that culture may not support school achievement. The need for children's labor in the home (as harvester, or as babysitter) may also interfere with successful schooling.

Poor health and malnutrition may also be significant factors in limiting school achievement. For example, children in Uganda who appear to have suffered from malnutrition as infants performed significantly below all others on the Raven's Progressive Matrices test of spatial and perceptual abilities, and scored a full standard deviation below the mean in academic achievement. Those reporting they had hookworm also performed significantly worse. This evidence supports the hypothesis that an average child in an LDC comes to school less able to benefit from schooling than his counterpart in a developed country.

The teacher, when certified, has probably had about 12 years of schooling, four of it at a normal school. Almost invariably normal-school programs focus on subject matter and theory, and provide little practice. The instruction in subject matter may be given at the typical secondary level, so that primary-school teachers know little more about the subjects they teach than is contained in the primary-school curriculum. Thus, typical teachers are likely to be poorly trained and inadequately educated, although we have found that many who are highly motivated and dedicated function far more effectively than one might expect.

By developed-country standards, the physical classrooms tend to be inferior, and the material support--textbooks, paper, learning aids--is often minimal. Furthermore, classrooms often do not have places to lock things up, so that it is very difficult to accumulate materials of any value. Other factors may also play significant roles in shaping the learning environment of the classroom, factors such as: the teacher's expectations of the children, the impact of students' expectations on their motivation for learning, tracking (as in the establishment of ability groups), differences in age and in language background, and instability in the student population due to poor attendance, dropouts, or transfers. These factors have been little investigated in developing countries.

One intervention for improving the child's ability to learn is the school feeding program, which has been supported by substantial portions of the food from the U.S. PL-480 operation. Another is the provision of health care in the schools. Either of these strategies might be expected to increase both attendance and achievement; but to date there is little clear evidence on the educational effects of these strategies.

An approach to the problem of increasing "school readiness" is found in pre-school television programs. These programs are designed to be viewed by children in their homes, or in neighborhood centers. These efforts blossomed for a while in the wake of "Sesame Street." In Brazil ("Via Sesamo"), in Mexico ("Plaza Sesamo"), and elsewhere, licensed copies of "Sesame Street" were produced and broadcast on commercial networks. In Peru, the Ministry of Education produced its own readiness program, called "Chiquillines"; in Venezuela, pre-school broadcasting has continued for some time. Recent evaluations from Mexico have been skeptical of "Plaza Sesamo's" effectiveness; and of course, since television is involved, the potential audience is sharply reduced. We know of no radio pre-school programs, although the success of the Nicaragua Radio Mathematics Project in reaching first graders suggests some optimism that such a program could be developed. So we have little evidence that such an effort would lead to better performance in school, and in any case it is likely that only a small audience could be reached.

The main strategies now used to improve teacher quality are pre-service and in-service training. Most countries have upgraded the pre-service training of teachers, not only providing schooling to larger numbers of prospective teachers but raising the grade level at which training is provided. More superior normal schools are requiring a high school diploma for entrance. Because pre-service training is a long, expensive process, and only affects new teachers, efforts are being made almost everywhere to provide in-service training. This takes the form either of short workshops, or long-term training usually given while the teacher continues teaching with occasional released time. There is evidence, much of it anecdotal, that short-term in-service training does not produce lasting changes in teacher behavior. A general problem with such in-service training, whether it be a series of weekend workshops or two months in the summer, is that it sends the retrained teachers back to work in the same classroom with an unchanged learning environment. Facing the frustration inherent in the trial-and-error applications of new methods that will precede their mastery, teachers will find it easy to slip back into customary practices.

Improving teacher ability has been another target of broadcasting projects. The Kenya teacher-education project was basically a correspondence course designed to prepare teachers to pass certification examinations. The program used radio lessons to supplement the printed material and to help teachers pace their work. India, in a project related to the Satellite Instructional Television Experiment (SITE), produced radio and television programs to be used as part of multi-media teacher-training workshops for science education. In perhaps the most ambitious project yet planned, Nepal will establish a year-long in-service teacher-training program using daily radio broadcasts, complementary printed materials, and summer workshops. USAID is providing much of the technical assistance for that project. Most of these programs rest on the assumption that retraining alone, without other reforms, is an effective strategy for improving quality. Our skepticism about that assumption leads us to a discussion of the third aspect of quality improvement, improving what happens in the classroom.

S. P. Heyneman (1978) cites several studies which showed a positive relationship between textbook use and student achievement. Few studies have compared the cost-effectiveness of texts with alternative interventions, however. Also, lack of an adequate distribution system, and the common practice of charging students for texts, are severe obstacles to the use of texts in many situations. There seems to be little argument for using more elaborate instructional materials, such as audiovisual aids, in situations where there are not sufficient textbooks, paper, pencils, rulers, and supplementary reading books. The cost of such materials is likely to be prohibitive, although materials obtained locally (stones for counting and such) may be useful and inexpensive.

There are two somewhat different ways that broadcasting is used in classrooms to improve the quality of instruction: to provide enrichment, or to give direct instruction. Almost all use of radio or television in the developed world is of the first kind. The second use has found favor in the developing countries. Examples include the early Colombia ITV project; the Ivory Coast ITV project; the Thailand project and the El Salvador ITV project.

El Salvador used television as the wedge for a comprehensive reform of its school system. While television is now used to some extent in the first six grades as well as seventh through ninth grades, most of the information available (and the comments here) come from the first years of ITV when only the latter three grades were included. In 1969 the public seventh through ninth grades were serving only a small part of the existing demand; fewer than 35% of students in sixth grade in 1968 continued into seventh grade the following year. The curriculum included a large number of subjects, and retained the flavor of its colonial origins. Instructional quality, by all accounts, was poor.

As a major component of an extensive curriculum reform, television was introduced to carry the core of the curriculum. Every week from two to four 20-minute programs were broadcast in each of five subjects. Each lesson was designed to be preceded by 10 minutes of motivation and followed by 20 minutes of reinforcement activities conducted by the classroom teacher. To enhance the utilization of the telelessons, production teams prepared printed teacher's guides and student workbooks. By 1976 there were upwards of 90,000 students in public seventh through ninth grades compared to about 22,000 in 1966.

Students who studied with ITV and the other elements of the Educational Reform over three years gained 15-25% more points (above their scores three years earlier) on general ability examinations than did their peers who studied under the traditional system, and those who had studied with all elements of the Educational Reform except ITV. Overall, ITV students also performed better on achievement tests in Mathematics, Social Studies, and Natural Science, and particularly so in seventh grade. Reading capabilities of both ITV and non-ITV students advanced at about the same rate.

The introduction of ITV and the Reform was accompanied by an increase in the number of students per class, and an increase in teacher hours with a less than proportional increase in teacher pay. This effectively lowered the cost per student of the classroom teacher. Thus although ITV was an add-on cost, when enough students were enrolled the total per-student cost of classroom teaching plus television was actually lower than the cost would have been within the traditional system. In a year in which 60,000 students were using ITV, the per-student cost of ITV plus the classroom teacher was $47. This was lower than the $52 it would have been if ITV had not been used, class size not increased, and teacher load not changed. Thus, with a four-fold increase in access as well as an improvement in quality, the per-student costs declined.

Another successful experimental example is the Nicaragua Radio Mathematics project, sponsored as a research project by USAID to assess the feasibility of teaching primary-school mathematics by radio in a rural area of a developing country. The project has been working in Nicaragua since mid-1974, producing one grade level of instructional material each calendar year. During 1978, lessons were being broadcast to grades 1 through 4 in selected regions of the country. Project lessons occupy approximately one hour a day, with half the lesson taught by radio, the remainder by the classroom teacher following a guide prepared by the project staff. In multi-graded classrooms, lessons are used by students at one grade level while the teacher works with students at another grade level (in the same classroom). Radio lessons are characterized by a high rate of student responses; children give answers orally or in writing on the average four or five times a minute. The program also uses physical activities and music to provide breaks between segments of instructional dialogue.

Radio Math uses a carefully structured instructional dialogue, based on an elaborate curriculum design that builds skills sequentially, but uses the radio rather than the classroom teacher to conduct the dialogue. This permits the teacher-training requirements of Radio Math to be very low. This type of project shifts some of the burden of instruction from the teacher; the media, used well, can mean important improvements in school quality. But more often than not that has not occurred, and major failures have been recorded. Although radio reception is relatively inexpensive, preparation of effective instructional programs is not. And ultimately, the success of an instructional program depends on the design of the curriculum and the way the students interact with it.

Considerations in the Use of Broadcasting in the Primary School Classroom

The usual image of TV watching or radio listening, reinforced by our own experiences with commercial broadcasting, is one of passivity. Children sit glued to the set--taking in what is delivered without active involvement. Educational radio and TV have more often than not been used in this fashion. However, as we have seen in the Radio Math project, this need not be a characteristic of media use. It is not only possible but desirable to design broadcast lessons that are highly interactive. And even a small amount of participation may represent a worthy advance over the current standard; in many areas the traditional teacher in a rural classroom neither encourages nor permits active student participation.

Broadcast media deliver a standard message to all members of an audience, and media use is cost-effective only when this audience is large. For instructional programs, this means that both content and pace have to be standardized. We do not consider standardization of the curriculum a drawback. Typically, educational systems are able to agree on the appropriate content for the core primary-school subjects; the difficulty in most systems (even in the United States) comes in assuring that this material actually gets taught in the classroom.

This difficulty is particularly acute in developing countries for several reasons. First, a proportion (in some cases, a large proportion) of the teachers are undertrained in both content and methods. Second, most countries have in the past decade instituted curriculum reforms but have been unable to support these reforms with adequate in-service training. One important outcome of the El Salvador TV project was to create the occasion for massive retraining, but such an effort may be completely impractical in countries that are larger and/or more geographically diverse. Thus, only recently trained teachers can possibly be equipped to teach new curricula--and they might not be. "Standardization," as effected by broadcast lessons, may actually mean that the quality of instruction will, on the average, be raised, as with Radio Math, even though individual differences and local conditions are ignored.

Teaching everyone at the same pace is a good deal more problematic and, if a defense is to be mounted, it must be on practical and not on pedagogic grounds. We think that the gains that accrue from assuring that the specified curriculum is actually taught and that effective teaching methods are used, advantages conferred by using broadcast media, outweigh the losses from not attending to individual differences. The major argument in support of this position is that very little is known about how to individualize teaching effectively. Despite large expenditures for experimental programs in the United States, there is little evidence so far that individualized instruction programs raise achievement scores. It is also possible for well-meaning attempts at individualization to backfire. Tilson found in rural primary classrooms of Nicaragua that teachers who grouped students by ability spent up to 40% more time with the high-ability group than with the low-ability group. In this situation, "individualization" worked against equity. Interestingly, the use of radio lessons reversed this finding; for both the radio-taught and the teacher-taught portion of the mathematics lesson the teachers spent more time with the low- than with the high-ability group.

The major constraints to using broadcast media for classroom teaching are: the resources required, the need for cooperation of teachers, the required support materials, the suitability of subjects being taught, and language standardization. At first glance, the media may appear as cheap solutions to the difficult problem of reaching large numbers of widespread classrooms. On the contrary, the successful use of broadcasting as teaching tools requires a significant financial investment in software as well as hardware, as well as capable personnel in all parts of the system, and a supporting infrastructure within the Ministry of Education and the other government offices and private enterprises needed to maintain media programs.

The research and development effort for new curricula is an important cost item that has too often been undervalued. Curriculum development is a sophisticated skill requiring knowledge and experience in instructional design as well as understanding of audience (learner) characteristics. And because an important feature of broadcast media in the classroom is their capacity to overcome the limitations of the teaching skill of various individuals, curricula must be designed in order to minimize the dependence on classroom teachers. It is expensive to train curriculum-design specialists, and in order to justify this investment an infrastructure must be provided that guarantees newly trained specialists the opportunity to continue using their skills.

Resources must also be spent on the installation and maintenance of hardware, and the continuous monitoring of the effects of the broadcasting program. Since this entails feedback from the remote locations receiving broadcasts, such monitoring usually has a substantial cost attached to it. In every classroom where broadcast lessons are intended for use, the teacher must tune into the broadcast. This sounds simple enough, but experience has shown that when radio or television receivers break down, teachers sometimes fail to have them repaired; that at the hour of the broadcast, teachers may either forget or choose not to tune in; that poor reception discourages teachers from continuing a lesson or series of lessons; that for various reasons parents or headmasters can pressure individual teachers to ignore broadcast lessons; and that sometimes teachers themselves resist using the media. Any of these circumstances will prevent the best designed lessons from reaching the classroom.

In many cases, broadcast programs are accompanied by printed materials--exercises, supplementary texts, exams, etc. This has been especially true in programs designed originally as correspondence courses. Like the broadcasts themselves, these materials must be skillfully designed. Equally important, they must be distributed as scheduled to every classroom using the broadcast lessons. In geographic regions where the media are being used as a means of overcoming problems of remoteness, difficulties in delivering supporting materials on a regular basis could detract critically from the effectiveness of the lessons. If it is possible to eliminate such materials, or otherwise minimize their cost and the complexity of their distribution, much will be gained in terms of the feasibility of media-based projects.

Furthermore, the subjects that can be taught over radio and television are limited, both by the kinds of equipment required to learn the skills being taught and by the amount and nature of student participation to which the subject lends itself. In regard to equipment, it is clearly difficult to teach woodworking over the radio if students do not have wood and tools. And other mechanical skills--often those very useful to youth in remote rural areas--require materials and tools for effective instruction. In regard to student participation, it is perhaps less obvious but nonetheless true that the learning process entails active participation by students. The success of the Nicaragua Radio Math Project can be attributed in part to the active participation of students in the lessons. Whereas mathematics and language are subjects that can call on frequent and varied responses from students, others such as history and civics are more abstract and less amenable to closely structured student participation. Yet it seems that without this kind of participation, broadcast lessons may have less advantage over traditional instructional methods.

Lessons must be broadcast in a language understood by the students. This constraint can limit the range of classrooms able to use media-based lessons emanating from a single source. Often the official language of a nation--Spanish, French, English, Arabic, etc.--is not actually used in remote regions, so that students cannot understand a broadcast well enough to learn from it. Broadcasts may be translated into local languages, but there must be a critical minimum of classrooms with students speaking a language to justify the cost of producing and transmitting such programs. Finally, even if students are familiar with a language in a linguistic sense, the content of the discourse may be too strange to them to have meaning. Descriptions and illustrations that fall outside of the students' realm of experience can cripple their ability to comprehend the message.

In summary, mass media has a potentially powerful role in extending primary education. There are many pitfalls to avoid, problems to solve and modifications to make if the results are to be as good as they can be, and it is necessary to be aware of all the indirect costs that will be incurred. But the goal of a more widely educated population makes the attempts to overcome these obstacles well worthwhile.

[Extracted from The Role of Communications in Education, pp. 32-71, a report of the Institute for Communication Research, Stanford University, for the U.S. Agency for International Development, December 1978.]

Note: The Nicaraguan Radio Mathematics Project has been suspended since this report was published due to the Nicaraguan civil war. The future of the program is still awaiting decisions by the new administration.

A Rural Alternative to Primary Schools in Upper Volta

Institut d'Etude du Developpement Economique et Social (IEDES)

[This article describes the experience of a poor African country in establishing low-cost rural-oriented schools for teenagers as an alternative to conventional primary schools for children. The results are inconclusive; the program's low costs and lack of access to higher schooling have made it appear discriminatory.]

Upper Volta is one of the poorest countries of the world by whatever measure is applied. Almost 95 percent of the population are engaged in agriculture, most of them in smallholder subsistence farming on lands of communal ownership. Employment opportunities outside agriculture are few, mostly in government services. The formal school system, modeled on the French pattern, is embryonic and spread thinly, though enrollments have been increasing. Primary schooling is available to only 1 in 10 of the age group concerned. There is a heavy urban bias: in towns about 65 percent of the children between 6 and 12 years attend primary school, in rural areas less than 8 percent. Only half of those who begin school are likely to complete the six-year primary cycle.

The educational dilemma facing newly independent Upper Volta in 1960 was seen to be acute. By the time of the 1961 UNESCO Conference which established the regional goal of universal primary education, it was clear to Voltaique authorities that such a goal was not a feasible option in the foreseeable future. In 1961 the government attempted to face up to the

The Institut d'Etude du Developpement Economique et Social of the University of Paris, France, was commissioned to make a study for the International Council for Educational Development (ICED), with headquarters in Essex, Connecticut.

realities and decided to experiment with an alternative approach, embodied in a law that gave birth to the Rural Education Centers.

Rural Education Centers

Origin and purpose. The initiative for launching an experimental scheme of rural education as a basic form of primary education combined with vocational training grew out of discussions in the late 1950s among educational planners in the Ministry of Education, when Upper Volta was still a French colony. The first plan was formulated by Medard and Christol, two Frenchmen working in the Ministry, and approved by the Legislative Assembly in 1959. The "Plan Christol" suggested that, given the low level of economic development of the country, it would be impossible to allocate the funds necessary to provide universal primary schooling for all children and adolescents in Upper Volta for many years. Although more than 600,000 children were of primary school age, the capacity of the school system was only 50,000 pupils at that time, and only a handful of those who entered the first year of primary school could expect to reach secondary and higher levels of education.

The Plan Christol advocated a sharp deviation from previous policies: universal primary schooling should no longer be the first objective to be pursued. Instead, the primary schools should be given the role of providing basic training and education for the few who would be most likely to enter secondary schools and ultimately to form the nation's elite. For the masses of the rural population an education focusing on rural life should be provided, with three years of agricultural vocational training combined with instruction in basic literacy in French and numeracy sufficient for effective work in agriculture and for a literate adult life. This broad, vocationally-oriented education should be geared primarily to the learning needs and capacity of the average youth. The plan proposed that for some time the intake of children in rural areas should normally be once every three years at age 14 or 15 (no longer at age 6) and the school leaving age should be 16 or 17.

A great number of advantages were envisaged. Since the higher age-group for the rural education program is smaller than that of the normal primary school age-group (child mortality is high), it would cost less to provide teaching and facilities for older children than for all children. Older children could be expected to be better motivated, better disciplined, and better able to learn than children at age six. More material could be taught in a shorter period of time than would be needed in a conventional primary school. While learning to work, the students would also be producing. More important still, by using modern methods in the fields, those in the rural education center would set an example for others. Thus rural education would have an immediate impact on the production of the whole village.

The principal aims and assumptions of the project may be summarized:

1. to provide opportunities for all rural youth to receive at least a minimum of literacy and numeracy by attending a full-time school during adolescence;
2. to inject an element of modernization into the villages by training all young people in the basic principles and methods of modern agriculture;
3. to lower the total cost of education for the masses by combining education with practical farm work, and by shortening the total period of education during the first decades of expansion of the educational system;
4. to reduce wastage in education by concentrating the teaching on a more receptive and better motivated age-group than that normally taken into the primary schools.

The Plan Christol envisaged that the expansion of primary education, which had been slow but steady during the 1950s, would be slowed down. Most of the funds anticipated for further development of the total school system could, therefore, be used to expand the rural education system. It was estimated that by 1970 approximately 76 percent of all boys and 24 percent of the girls would have an opportunity to go through a course of rural education. After 1970 the rural education system would be gradually expanded to take in both boys and girls outside the formal school system until, ultimately (before 1985, it was hoped), the whole youth population could be given some kind of elementary education. Only then would further expansion of primary education be permitted, mainly by an extension of the rural education system to lower age-groups.

Implementation of the scheme began in 1961 when the first group of teacher candidates was recruited and trained in a short course of five months. The first centers were constructed in 180 villages, and 8,100 students were selected to participate. Most of these centers were built with local materials, using the same techniques as those employed in building rural homes in the country.

Expansion of the program was rapid after the first years of experimentation and search for a methodology. By the end of the 1970/71 school year, 759 centers were in operation; of these, 680 centers were for boys and 79 centers for girls. They had a total of 21,598 students recorded in attendance at the end of the school year. Students in rural education represented about one-fifth of the total school population in Upper Volta. Between 1965/66 and 1969/70, REC enrollments rose from 21,000 to 26,000, and then dropped by about 20 percent in 1970/71. At the same time, enrollments in primary schools rose from 93,000 to

102,000. However, compared with the primary school, the RECs had lower dropout rates and fewer students per teacher and there were no problems of repeating since individual repeating was barred in the REC. Although completion rates were relatively high, they tended to worsen: in the period 1966-70, for every 1,000 starters, 878 completed the course; during the overall period 1966-72, for every 1,000 starters, 760 completed full courses.

Table 1

ENROLLMENTS

	RURAL EDUCATION CENTERS	PRIMARY SCHOOLS
1959	0	50,000
1966	21,000	93,000
1968	26,000	---
1971	21,598	102,000

The expansion of the REC system fell far short of the original goals. By 1972/73, there was a drop in the number of RECs to 737, although enrollment increased to 24,000 youths (84 of these centers enrolled 2,500 girls), which is no more than one-sixth of what had been projected. Meanwhile, regular primary schools continued to expand steadily and, in fact, to get the lion's share of the education budget.

Assistance was sought for the program from the European Economic Community-sponsored European Development Fund (FED), which agreed, in 1961, to finance 225 centers to be established for 11,250 boys. Smaller contributions were received from UNICEF--mainly tools and equipment; from the Food and Agriculture Organization (FAO)--seeds, fertilizers, and gardening tools; from French bilateral aid--books and documents mainly for language teaching, and resources for printing basic agricultural education manuals used in the schools; and from bilateral and private American sources--various teaching aids and some food to help feed students during the months before the harvest.

Personnel. Teaching staff is trained in three centers, two for boys and one for girls. Candidates for teacher training should be at least 18 years old and have an education corresponding to at least ten years of primary and secondary school. The educational level of the candidates has risen over the years. There are no special requirements relating to practical experience. Teacher training takes 10 months and covers a wide range of subjects including:

General education
    French
    Arithmetic
    History and civics
    Physical education
Agriculture
    General agriculture
    Applied agriculture
    Breeding
    Rural infrastructure
    Water and forests
Agricultural fieldwork
Workshop (use of hand tools and simple construction)

Preservice training is supposed to equip the teacher for his multiple duties in the village, where supervision with only one counselor for each 100 centers is inadequate, to say the least. The lone teacher in the village REC is expected to supervise and carry out instruction, manage a profitable school farm, account for the produce, organize school cooperatives, act as local *animateur*, form a liaison with the village leaders--both to gain their assistance in running and maintaining the school and its equipment and to reciprocate by providing services to the village. In return for this variety of heavy duties he would be paid only half the salary of his counterpart in the primary school, have a more limited security of job tenure, and almost certainly have inferior housing. These conditions have made it difficult to recruit and hold good quality staff, and the poor morale in the REC structure and teaching services has led at its worst to fraud and absenteeism, and at its best to an unending uphill struggle for the rural teacher whose enthusiasm is difficult to sustain.

Activities. The curriculum of agricultural work follows the seasons--beginning with the turning of the soil when the rains come in June or July and finishing with the harvest in October or November. If the center has a sufficient water supply for irrigation, the teacher can prolong agricultural instruction in the school garden, but not all centers offer such possibilities. Practical work during the dry season is devoted mostly to crafts, using elementary tools and local materials, or whatever the teacher and the students can find in and around a poor village in a country where wood is scarce.

Classroom lessons during a major part of the first two years are devoted to the teaching of basic French. The target in the first year is to teach the students at least 600 words, with an equal number of words added in the second year for the basic needs of conversation. The methods and the textbooks are, in most cases, the same as those used in the primary schools. Two factors make this first period of teaching extremely difficult: the absence of French in the environment--few villagers know any French--and the fact that the students and teachers sometimes speak different indigenous languages. The young people often study the texts without really understanding their meaning. It usually takes a long time before French becomes an effective medium of instruction in the schools. Because of this factor, the teaching of agricultural science, civics, and related instruction is often put off until the third year, a postponement that greatly diminishes the effectiveness of the educational program.

In principle no male student should be less than 15 years old and the median age should be 17. In fact, the median age is lower, with some students as young as 11 years. The age level of students has proved to be an important determinant of the efficiency of rural education. In general it has been found that the younger students are less well motivated and have greater difficulties in outdoor activities than the older ones. On the other hand absenteeism is higher among the older students, particularly during the planting, weeding, and harvesting seasons.

REC Performance. The IEDES study team attempted to assess the performance of RECs by conducting field investigation in two of the 11 districts--Yatenga and Koudougou. The team gave written performance tests or interviewed 256 final year REC students, 114 former REC students, and 81 former students of primary schools in the two districts. The team also interviewed village chiefs, heads of family holdings, village notables, parents of REC students, REC teachers, REC counselors, and rural development organizers about various aspects of REC operations.

The test results indicate that about half of the third year students in the selected RECs had acquired the basic mechanisms of reading, writing, and computation at an elementary level, and presumably this limited knowledge could be applied outside the school context in solving practical problems of life. However, practical application depended largely on whether students would have the opportunity to build on the foundations laid in REC and to improve further their level of facility in the basic skills. According to the test results, the majority of the rest did not learn to read and write or to do basic calculation. Some who acquired rudiments of basic skills probably did not learn enough to make use of these skills functionally outside the school context.

The results of the agriculture test were no more promising than the French and computation test scores, even though supplementary explanation in Moré, the local language, was added to the original questionnaire in French. The average score in agriculture for the whole group was 17 out of a maximum possible score of 40. Incidentally, the teachers of nine RECs in the sample were invited to answer the agriculture questionnaire, and some of these responses (for some questions, eight responses out of nine) were found to be incorrect.

The literacy test was given to 42 former REC students and the computation test was given to 21 former students. The scores collected from such a small sampling do not permit valid conclusions; however, the test data supplemented by impressions from interviews suggest that of the REC students who acquire the basic reading, writing and computation skills, some do not retain these skills and make use of them in practical life. In Yatenga, where organized follow-up activities in the form of post-school groups have been an important factor in the retention, use, and further improvement of the basic skills of those who originally acquired them in REC, scores were higher than in Koudougou. By way of comparison, 34 former students of primary schools aged 17 years or more were given the literacy and computation tests. The test results, again based on a very limited sampling, suggested that the former primary students as a group were ahead of the REC students in both literacy and computation skills. However, the former primary students were a self-selected group, taking the test voluntarily; a more representative sample might well have produced less favorable results.

The results obtained in agricultural production have been studied on three occasions by the counselors of the rural education system. The span between the low and high productivity in the centers was very wide. The 25 centers producing least had an average income in 1969/70 of only CFAF 3,529 (US$14) while the 25 highest-producing centers earned an average of CFAF 84,000 (US$340). While the scope of cultivation, that is, the number of different crops grown at each center, might be considered satisfactory, the methods used in many centers were not. Only one out of every three centers in 1969/70 put fertilizer into their groundnut fields, a recommended practice. The cotton fields received fertilizer in 182 centers out of 319; and 187 centers made one or more sprayings during the growing season where three to four sprayings are recommended by the extension service. The main reason for not following the advice appears to be the uncertainty of rainfall (which may turn the investment into an expensive loss), lack of the necessary implements, and shortage of operating funds. Thus, many centers do not give their pupils adequate training in the application of modern agricultural methods, and less than 50 percent of the centers reporting yields are able to show higher production figures per hectare for various crops than the average farmer can obtain in his own fields.

As for the attitudes of the graduates of the RECs compared with those of early dropouts and failures of the formal schools, the IEDES study concluded that REC graduates were better emotionally equipped to face challenges in their home environment, while the formal school dropouts felt isolated and guilty of failure and thought only of fleeing the village. The rural education student, on leaving the center, had no such discouragement, particularly if there was a post-school group in existence. This probably is more a function of different expectations of parents and students in respect to primary schools and

RECs than of the performance of these institutions. The primary school is seen as the means of escape from the village; when this does not materialize, students feel frustration. The REC aims at preparing its students for a livelihood in the rural milieu.

Costs. The rural education system was deliberately designed as a low-cost operation. At practically every point in the buildup of the system, efforts were made to cut the costs to the lowest possible figure and to make classes as large as possible. As a consequence the per capita annual current cost of rural education is no more than 40 or 45 percent of that of general primary education. The investment costs for the government in the average self-help school building, excluding the contributions in kind from the local population, amounted to less than US$1,000 for each center, and for the most part were in the form of tools and equipment for work in the fields and for wood- and metal-work activities. Centers built with FED aid were more costly.

The major current cost of the centers is the salary of the teacher. Little money, if any, is spent on repair and maintenance of equipment. Only a few centers have draft animals, and those that have them normally do not have any direct cost for feeding them; they graze with other animals of the village. Little is known about the opportunity cost of students in the rural education centers, of the sacrifices made by parents in letting their adolescent children go to school for 35 hours a week for some 40 weeks a year for three years. There is reason to believe that families find this opportunity cost rather high.

Issues in Rural Education

Question of objectives. The program began as an experiment in providing elementary education and teaching practical agricultural skills to the 90 percent of youths who had no chance of going to the primary school. The original intention was that the expansion of the traditional primary school would be halted; ultimately the two kinds of institution would merge into a unified national system of basic education for all children--with both institutions enjoying "parity of esteem."

What really happened was, of course, very different from intention. The number of new RECs remained well below the number planned and became almost frozen after 1968, while primary schools continued to be expanded in the cities and towns at a steady pace. The primary school remained a highly selective institution, ruthlessly pruning the number of participants, granting a small proportion the privilege of completing the six-year course and opening up for them the opportunities and the rewards of white-collar occupations. A student in the REC, on the other hand, irrespective of his talents and ambitions, had little chance of transferring to the formal system and claiming a stake in the perquisites associated with it. Moreover, the proclaimed objectives of the REC, in most cases, were not fully achieved. Parents of rural youths and the youths themselves, of course, clearly saw what was happening and regarded the REC, at best, as a temporary expedient that should be replaced by the real thing, the primary school, and at worst, a symbol of discrimination against the rural people. In fact, as the IEDES investigation has revealed, parents continued to hope that the REC would be converted to a regular primary school and tried to send primary school age children to the REC. But when after a three-year cycle the REC was not converted into a primary school, the villagers' hopes were shattered and new REC recruitment efforts faced increasing resistance from the villagers.

The ambivalent attitude of the government towards the objectives to be served by the program and the lack of comprehension of its aims by its clientele--or their shrewd reading of government ambivalence--obviously do not augur well for the program. It is doubtful that the program can be effectively expanded and that meaningful results can be achieved from it unless the stigma of blatant discrimination is removed from it, and ways are found to restore its original purpose.

Links with other rural activities. A rural education program, especially one of a practical nature and designed to bring about improvement in rural living conditions, cannot be viewed in isolation from the overall rural development effort. The Upper Volta farmers, burdened with poor farm land, entirely dependent on the vagaries of the weather for their next harvest, and always concerned about producing enough food for survival before taking chances with untried methods, need far more than just knowledge of new agricultural techniques. In a situation where the animal-drawn plow is virtually an agricultural revolution, not because the farmer does not know its value but because he cannot afford the price of the plow and the animal, villagers can be justifiably skeptical about a program to teach better farming practices unless the program is linked to an overall attack on the obstacles to poor farming.

IEDES interviews with villagers revealed that they associate various development services and institutions (such as health clinics, transportation facilities, stores for agricultural supplies, and market centers), not with the REC, but with the primary school. It may not have been planned that way, but the location of the primary school coincides with the location of these services. At least some villagers believe that once a primary school is opened, the other institutions will follow, whereas the REC can apparently offer no such prospect. This belief may be unfounded, but it reflects a perception of the REC role in rural development.

Support and commitment. Establishing a role for a new rural education program and making it a key element in a national endeavor to provide basic learning opportunities to all call for a national commitment by political leaders, the administrative personnel, and the general public. It may safely be said that the REC does not enjoy the unequivocal support of the government. The program still remains officially labeled "experimental" even after more than ten years of existence.

A comparison of the primary school and the REC in respect of the teachers' remuneration, physical facilities, and provisions for equipment and supplies immediately tells where the government priority lies. It is true that the RECs were intended to be community-supported institutions, and one reason for their existence is that they are low-cost alternatives to the primary school. But a comparable cost-saving effort has not been applied to the primary schools, even though the educational task assigned to the REC is considerably more complicated than that of the primary school. Costs can be too low when very little achievement can be shown for them.

While any realistic program for rural education must take advantage of all cost-saving opportunities and make efficient use of available and new sources of support, it obviously must have basic resources that are commensurate to the tasks it is expected to perform. If the program can engender community support, the financial burden on the government can be partially reduced. In the case of REC, government financing has been inadequate and community support has lagged, in part because of a lack of popular enthusiasm for the program, but also because of the crushing poverty of the Voltaique rural families.

Operational problems. The choice of the medium of instruction poses a difficult problem in French-speaking Africa. French is the medium in RECs, presumably because it is the language of government and business; and it is also used in the primary school. Contacts with government personnel and people from outside the region, as well as business transactions in the market town, demand a knowledge of French. It would be difficult for the more ambitious rural youth to get ahead in life without a knowledge of French. On the other hand, a disproportionate amount of the students' time and energy during the three years is spent on what for most students amounts to a smattering of spoken French and an even more limited functional facility in reading and writing. IEDES researchers have noted that much is lost in the process of communicating technical agricultural information to the REC students and, subsequently, to the villagers because French is used in the centers. An alternative that might have been given at least a trial is Moré, the language of the Mossi people that is spoken and understood by more than half of the people of Volta. It also has a written form in the Roman script and printed publications, including the Bible. While teaching in Moré would have been more efficient, it might have reinforced rural people's perception of REC as a symbol of discrimination.

The multiple roles and responsibilities of the REC instructor and his relatively meager rewards compared to those of the primary teacher have been noted. He is left virtually alone to fend for himself in an essentially unpromising atmosphere without much supervisory and technical backstopping or opportunity for professional growth. Supervision is so lax in some districts that, according to IEDES, one center has not been open to students for six months, yet the instructor has collected his salary regularly every month. Supervisory and technical help to the field personnel in a rural education program is more important than in a traditional primary school where the teacher's role and the instructional content is more well defined.

Another essential kind of backstopping lies in selecting and adapting the content of instruction. The experience of agricultural extension in general shows that the extension service can be effective only when there is a systematic provision for responding to the changing needs and problems of farmers by validating the extension message and adapting it to the specific situation. The REC, however, continues routinely to propagate certain stock practices, and attempts to implement them in the center farm within the limits of its meager resources, while the villagers are forced to cling to their own time-tested methods as the best insurance for survival in the face of climatic vagaries.

The RECs are in an untenable position, because they are expected to manage model farms where improved farming techniques are practiced, yet none of them have been provided with even a modest complement of agricultural tools considered essential for their operation, and most have received as donation the poorest of the poor village land for their farms. While the REC farm should not set standards of cost and investment totally out of line with those of the village farms, it needs to be provided with the resources to carry out initial experiments and demonstrations. It is not designed to be a self-financing operation. A scarcity of essential supplies, such as books and paper, is probably another indication of lukewarm government enthusiasm for the program.

The REC experience clearly demonstrates the vital role of follow-up activities for the trainees of a rural education program. RECs and similar occupationally-oriented programs by themselves cannot carry on effective follow-up activities. The factors that are helpful to the follow-up activities--the overall rural development milieu and the imagination and dedication of the educational program managers--are also the factors that contribute to the good performance of the REC program itself. It should be noted, however, that the post-REC groups have taken root in one district only through individual initiative, and have yet to spread to other areas--although they have met with government approval and their importance is now well recognized by REC authorities.

Recognizing the contradictions in the REC program, the government instituted some major changes in the program in 1974. The RECs have been taken out of the Ministry of Education and placed under the Ministry of Planning and Rural Development and renamed as the Young Farmer Training Centers (Centres de Formation de Jeunes Agriculteurs), or CFJAs. A plan is underway, with assistance from the World Bank and the European Development Fund, to strengthen the Rural Development Organizations in five districts. It is expected that these RDOs and the CFJAs, now under the same national ministry, would work closely with each other. The plan provides that the trainees from the centers are to be encouraged to form cooperative post-school groups and are to receive assistance from RDOs in establishing farming and other economic enterprises. The results of these changes have yet to be seen.

Conclusions. It may reasonably be argued that the system as it was originally conceived has been given something less than a fair trial. What was intended to have been the major national educational thrust has from the outset been only the "poor relation" of the formal schools.

It is evident that for poor countries with scanty resource endowment and only a thin spread of conventional schools, an REC-type system offers a way of spreading learning opportunities more widely than can be afforded by conventional approaches. There is evidence, too, that there are advantages to be gained by having an older age-group exposed to institutionalized learning and for a shorter time than the younger age-group in primary schools. Despite all the difficulties, the better centers have proved that the mechanisms of reading, writing, ordinary conversation, and computation connected with everyday life have been acquired (and in a foreign language too) by a sizeable number of students. The students undoubtedly also acquire new agricultural knowledge, even though they do not have the opportunity to apply all of it either in the center or in the village. Indeed, considering the limitations of resources, the briefer time span, the nonselective nature of the clinetele, and the broader scope of the objectives, comparison of the REC with the primary schools only on the grounds of literacy and arithmetic is unfair.

The "technical" feasibility of the REC program, and its ability to achieve some results in spite of all the difficulties, do not, however, ensure its future viability and effectiveness, at least in Upper Volta. The RECs, even in conjunction with RDOs, do not constitute a real attack on the main problems of rural Upper Volta--absolute poverty, poor soil, drought, and the inability of farmers to use farming techniques that they know can produce better results because they cannot afford the supplies or fear the risks to their livelihood. While the REC program remains incapable of contributing as much as was originally expected to making life better for the future farmers and rural residents, it also fails to open the door to the city and the modern sector of the economy, a promise that the primary school fulfills for at least some of those who succeed in staying in school long enough.

The lesson of the Upper Volta experience is that a rural education program cannot be effective as long as it stands as a symbol of discrimination and fails to gain the acceptance of the rural people. The stigma of discrimination can be removed, and the confidence of the rural people in the program regained, if there is a government commitment supported by necessary action to build a unified national system of basic education--or at least to remove the more pernicious elements of a dual system, and to provide the needed support for the program to succeed. This is a political choice that Upper Volta and all other countries seriously interested in rural education must make.

[Extracted from Chapter 9 of Education for Rural Development: Case Studies for Planners, Manzoor Ahmed and Philip H. Coombs, Editors, pp. 335-63. New York, Praeger Publishers; Copyright © 1975 by International Council for Educational Development.]

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Case Studies in Primary Education

Judith Brace and Barbara O'Grady

[The following case studies, briefly summarized, indicate some of the experiments that are being made in primary education in the developing world. Some of the goals they try to achieve are to spread primary education more widely, to serve community needs more fully in rural areas, to improve educational quality and appeal (i.e. lower dropout rates), and do these at low cost.]

1. India: The Social Work and Research Centre's Primary Education Project

The Social Work and Research Centre (SWRC) is an indigenous organization in Ajmer District, Rajasthan, whose basic aim is to strengthen the control that villagers have over their own lives. They sponsor innovative experiments in community organization. In this case their objective was to test a new teaching approach to providing basic education to meet the needs of rural children. The project described here was supported by India's National Centre for Education Research and Training from 1975 to 1978.

As part of their efforts to make schooling more relevant to problems of rural India, SWRC launched an experiment in primary education in the schools of three isolated rural villages. The experiment included three major changes from traditional schooling. The schools' regular teachers were reassigned to other areas and were replaced by six young local recruits with no teacher training--two farmers, two priests, a widow, and an unemployed youth. They were given a brief training session at the SWRC campus, followed by weekly workshops throughout the school year with SWRC staff and visiting

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specialists. These were open workshops, in which issues and problems were discussed freely and critically. New ideas were proposed and the schools' performance evaluated.

In order to make the schools as accessible as possible to the learners, the school hours were adjusted: younger students and those who were free attended a morning shift (8 a.m. to noon) while those who worked during the day attended the evening session (7 to 10 p.m.). This later schedule was especially suited to former dropouts who work. The objectives of the official syllabus in language and numeracy skills were retained, but the SWRC program designers made substantial changes in both the teaching methodologies and the curriculum. Changes were in line with the goal of providing students with more interesting experiences grounded in their own social, economic, and physical environment. The school was a "learning center" that had its own garden and animals. The village itself was considered an extension of the school and villagers with special skills were drawn into the school as "teachers." Subjects were taught through work projects, group discussion, field trips, and observation. Each learning center developed its own teaching materials and aids.

Results: From the beginning, evaluation was part of the experiment. Technical help for this was provided by the Regional College of Education. By the end of the second year, the number of 6 to 11 year olds attending school had risen substantially, and the dropout rate had declined. These students were then tested against their counterparts in two traditional schools of the region. Scores for reading and listening comprehension were considerably higher in the experimental schools. The results were the same with environmental studies. Although the difference was not as marked, arithmetic scores were also higher in the experimental schools.

The feelings of the community toward their experimental schools varied. Lower-caste villagers were more supportive than the upper castes. There was some lack of cooperation from the village leaders because of the schools' direct approach to the parents rather than to the leaders. As the experiment progressed, community support grew. Parents of one village, for example, offered free labor to dig wells for the schools.

As in many efforts of this sort, the care and maintenance of the school gardens created problems. In the SWRC case, the watering and other routine chores when the school was closed presented difficulties. In other instances, either fruits of the labors are often not democratically distributed, or children of lower class are expected to do all the work. Sometimes the schedule for animal care and the school schedule did not coincide; and there were some labor and cost problems.

The overall assessment of the primary program was that it had successfully shown that a radically different approach to rural schooling was possible, but that achieving best results required the dedicated and continuing attention of workers who believe in the ability of rural residents to solve their problems.

2. Guatemala: Primary Educational Development

Two-thirds of Guatemala's primary-age school children live in rural areas where there is only one classroom for an average 140 children. Of the 29 percent of the total school-age population that is in the school, only 2 percent reach the 6th grade; only 4 percent of the rural schools offer six grades. Of the adult population, 70 percent are illiterate. In a still on-going project started in 1971, experimental schools were founded to address this situation.

When Guatemala was seeking education funds from the U.S. Agency for International Development, The World Bank, UNESCO and the Inter-American Development Bank, the government made a detailed analysis of its educational system and devised a plan for reform. Four primary schools were designated "pilot schools": two were located in the Ladino (mixed Spanish and Indian) region, and two in the Indian highland areas. These four schools would serve as teaching laboratories; they would provide grades one to six, and become receiver schools for three to five "satellite" schools. These satellite schools were the traditional one-room, three-grade schools from which very few students had bothered to seek further education. The pilot schools hoped to reduce the dropout rate and thus the per-pupil cost.

The pilot schools serve as laboratories to introduce new techniques, and as teacher-training centers. Four other six-grade schools were selected as controls for comparison during the experiment. The pilot schools test project-centered instruction materials in arithmetic and the natural and social sciences, all of which are based on rural life. The staffs of each of the schools have developed supplementary textbooks for the specific regions and language of the pilot schools. Learning subjects include agriculture, health, nutrition, home economics, and industrial arts. The schools are provided with pumps, irrigation equipment, and libraries, and each school has land for a farm plot and equipment. The schools serve as centers for adult evening classes as well.

The pilot schools test new methodologies, new curricula, new administrative organization, and new supervisory techniques. With a tested method of improving primary education, it is hoped that secondary education in the country will later be upgraded. All aid organizations are in agreement that to improve secondary education, the quality of the student entering from primary schools has to be improved.

Results: Evaluation of the project showed that the output of the pilot schools' sixth grade had increased 40 percent since 1969. There were higher promotion rates in pilot schools than in the control schools for all grades (88.5 percent v. 55 percent) and higher enrollment in grades four to six in the pilot schools than the controls (46.5 percent v. 35 percent). In 28 major comparisons between the pilot and control schools, the pilot schools scored significantly higher in 21 grade or subject areas. A ratio of 40 students per teacher was reached in the pilot schools. Detailed curricula for each of six primary grades have now been developed and tested. A new loan-funded normal school is using these curricula and teaching methods developed in the pilot schools. For the first time, screening procedures for incoming teachers have been initiated. Out of 700 teacher candidates, 180 were chosen and trained at the pilot schools.

In the area of practical teaching, the schools' agricultural projects are now self-financing. Community parents in the pilot areas, under supervision of pilot school technicians, increased their corn and bean production 400 percent in 1973 through use of recommended fertilizers. Parents are participating in increasing numbers in school programs and are making use of the industrial arts shop facilities.

3. Philippines and Indonesia: Project IMPACT/Proyek PAMONG

In 1974, the South East Asian Ministers of Education Organization (SEAMEO) with funding from the Canadian International Development and Research Center and the Governments of the Philippines and Indonesia, attempted to develop an effective and economical delivery system for mass primary education. They came up with the concept of Instructional Management by Parents, Community, and Teachers (IMPACT). Two experimental sites were chosen, Cebu Island in the Philippines and Surakarta, Indonesia. In the former the project is called IMPACT, in Indonesia the acronym PAMONG (with the same meaning) is used. In both cases the project goals are to make primary education available to all children as the school-age population continues to rise, to use existing teachers more effectively, and to reduce the dropout rate and the per-student cost.

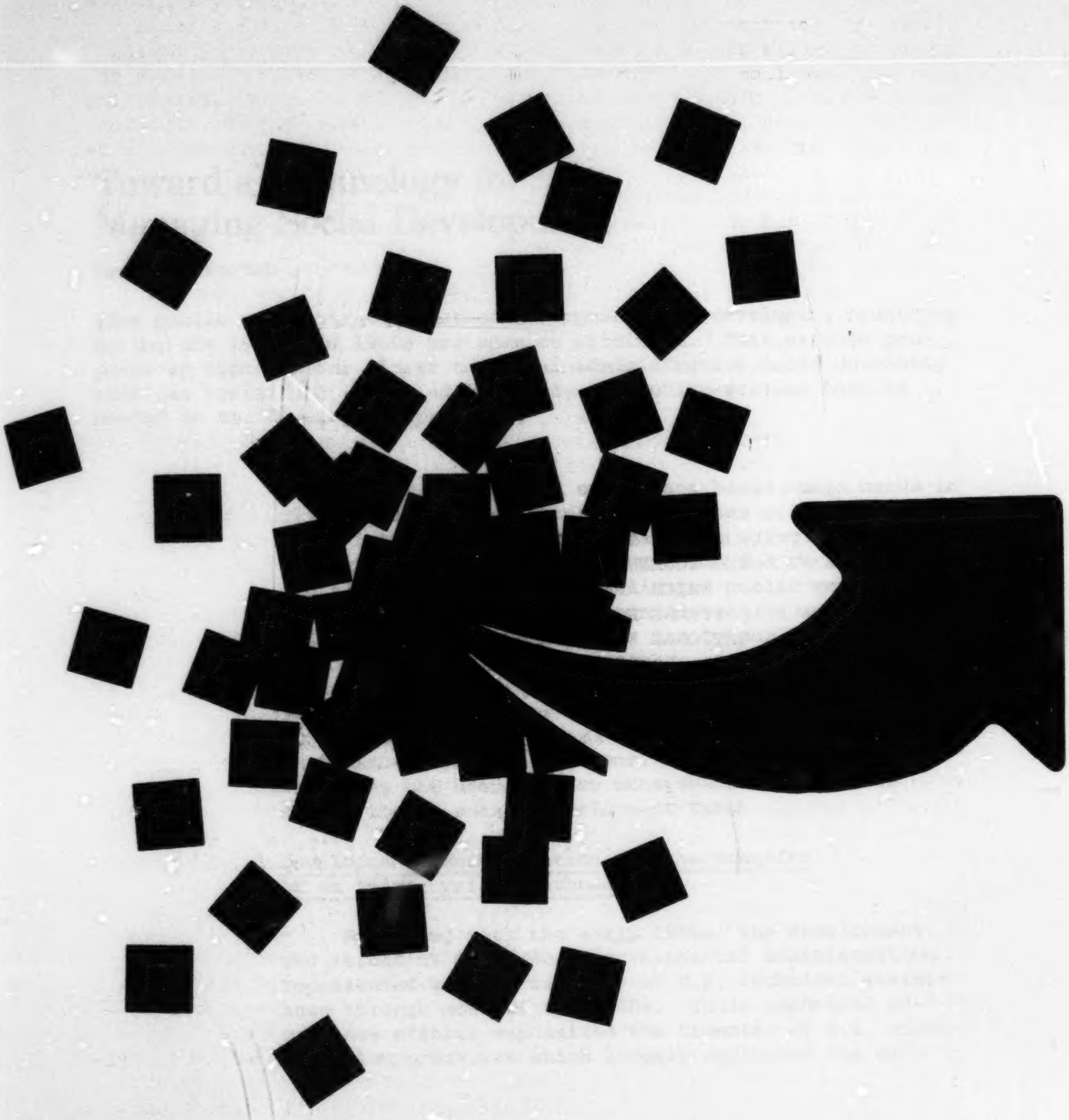
The teacher's role is changed from instructor to "manager" of a variety of instructional elements, including community volunteers, self-instructional learning modules, remedial classes led by older students, peer-teaching/learning, parental monitoring, and the overseeing of up to four times as many pupils as in a conventional setting. Of these various elements, the self-instructional modules are the core. The standard Government syllabus has not been changed but was rewritten in the form of modules. A module takes up one idea or subject, and "packages" the subject in the form of a self-instructional booklet that takes the student from a pre-test, through the concept to be learned, to a post-test. The pre-test indicates how much the student already knows; the post-test is given by the "manager" to see whether the student has learned the subject well enough to go on to the next subject and its module. It takes the average student about one week to complete one module.

Schools become community learning centers where classrooms are replaced by "learning kiosks" built by community parents. Here small groups of pupils gather to work on a subject module with their peers, and then move from one kiosk to another with other students to work on other modules. Older pupils rotate the responsibilities of instructing the lower grades in reading and writing, testing them in comprehension and simple mathematics, and using flash cards and flipcharts as intructional tools. Essential to the process is a keeper of records, for logging modules as they are taken and returned, for scoring and recording tests taken, and for keeping track of all the equipment. This person frees the former teacher, now an instructional supervisor, to spend full time monitoring academic progress of the students. The community learning center and its flexible study modules enable a student to return to the system at any time if circumstances have caused an absence. In the same way, adults or older youths can re-enter the system by simply checking out the programmed modules, taking the tests, and moving along through the grades at their own speed.

Results: Module learning was introduced in grades four and five initially; for students finishing traditional third grade, it was a difficult transition. The most difficult aspect of Project IMPACT/PAMONG was the training of the students to "learn to learn." Giving students carefully designed, simple modules was not enough. The children first had to learn the skills to deal with the modules. Module writers agree that it would have been an easier task to begin with the first grade and move along producing modules for these students as they pass through the grades.

Results from this experiment in programmed learning, however, have been promising enough to cause its expansion in both of the test countries to additional locations. The Standardized Official Test in the Philippines and the BP3K test in Indonesia showed higher test scores in mathematics for the IMPACT/PAMONG students than for conventionally schooled students. In the Philippines, an IMPACT student, on the average, scored 125 to a non-IMPACT student's 100; in Indonesia, a PAMONG student's score, on the average, was 107 to a non-PAMONG score of 100. Other subjects showed an even higher average score for the experimental students. In the Philippines, a saving of at least 15 percent in school operating costs has been estimated. AID is initiating a replication of the IMPACT/PAMONG system in Liberia (1978-1982), to determine whether these innovative mechanisms can be adapted to an African setting.

[Extracted from "Case Studies in Primary and Non-Formal Education and Management Training," a report prepared by the Academy for Educational Development, Inc., for the U.S. Agency for International Development, Washington, D.C., 1979.]



ORGANIZATION FOR DEVELOPMENT

DESIGN SYMBOLIZES THE BRINGING TOGETHER OF DIVERSE ELEMENTS WHICH ARE CONVERTED INTO A STRONG FORWARD MOTION TOWARD NATIONAL DEVELOPMENT. (GRAPHICS: BARBIERI AND GREEN)

Toward a Technology for Managing Social Development

David C. Korten

[The public administration methods recommended to developing countries during the 1950s and 1960s are open to criticism. This article proposes an approach far closer to actual administrative decision-making that can contribute to the adaptability in problem-solving that is needed in the development process.]

Recent emphasis on equity and basic human needs in Third World development strategies has stimulated renewed interest in the problems of managing development programs intended to reach the urban and rural poor, and placed major demands on limited public sector management capabilities. The administrative and analytical tools widely espoused for use by public sector development institutions in the past are now widely criticized as inadequate or inappropriate. This paper reviews the criticisms and examines some of the basic requirements of the social development process and their management implications. It identifies and discusses the need for new management technologies suited to the social development task.

Development Administration and the Transfer of an Inappropriate Technology

Beginning with the early 1950s, the development and reform of Third World governmental administration represented a major category of U.S. technical assistance through most of the 1960s. These technical assistance efforts emphasized the transfer of U.S. administrative practices which largely reflected the doc-

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trines of the 1930s: a combination of Weberian theories of bureaucracy and the principles of scientific management formulated by Frederick Taylor and Henri Fayol. The doctrines emphasized the separation of policymaking and implementation: administration was to be instrumental only, carrying out policies established by the political authority.

Administrative reform was seen as consisting of introducing values of rationality, hierarchy, responsibility, professionalism, specialization, and discipline into a bureaucracy. The central concern was with upgrading services like personnel, budgeting, accounting, organization, using methods practiced in the United States. At the same time a major reform objective was to transform the character and aims of government to be more responsive to development needs. A common solution was to create a national planning agency outside of the implementing bureaucracy. Planning, and the design of development projects, were policy-making activities, consciously separated from the on-going routines of government; they were to provide the central force for change.

Subsequent criticism of the approaches to administrative reform which prevailed through the mid-60s has been widespread, and sometimes caustic. Among the criticisms are the following:

1. The U.S. public administration technologies which were exported were inappropriate both to the task of development and to the environment in which they were to be used.
2. The emphasis on rules, procedures, formal structures, position classification, PPBS, and formal organizational specifications was better suited to system *improvement* within well-institutionalized socio-political systems than to the need of Third World nations for system *development*. Furthermore, these tools and techniques were not adequate for establishing organizations that would produce new outputs, stimulate new forms of behavior in their environment, and continue over time.
3. The separation of planning and implementation left the planners far removed from reality. It generated in some planners a sense of omnipotence and a disdain for the lesser folk who were simply to follow their directions.
4. Comprehensive, multisectoral planning called for unavailable information, nonexistent knowledge, and political steadiness in constant pursuit of aims to an extent undreamed of in the experience of most developing countries.
5. The emphasis on planning was at the expense of the implementing managers, on whose effectiveness and imagination the success or failure of a project was often dependent. The planning and control models failed to encourage an

ability to rapidly identify and solve problems, an aggressive attitude toward overcoming obstacles, and a sense of power to change and implement at lower organizational levels.

6. The technical assistance effort in administration was largely isolated from newly emerging insights in organization theory which were seriously challenging the "simplistic" models of the 1930s.
7. Planning activities tended to ignore the reality that power is dispersed, and that policy choices arise out of political competition among divergent interests.

In effect, the strongest and most readily available analytical and administrative technologies have tended to shape the definition of the development problem, rather than the reverse. Three basic requirements relating to the organizational dimensions of social development have tended to be neglected, with serious detrimental consequences.

- The need to design organizations capable of rapidly adapting to changing local circumstances.
- The need to organize urban and rural poor for participation in making policy decisions affecting their lives.
- The need to develop institutional linkages between center and periphery, between sectors, between programs and communities, and between political and bureaucratic systems.

[In this extract, the first of these three organizational needs and its managerial implications will be examined.]

Organization for Rapid, Purposive Adaption

Development-oriented organizations must be able to respond rapidly to local needs and circumstances. The true barriers to implementation of a development project are seldom foreseen in advance, nor are the creative responses by which these barriers can be overcome. Often circumstances are such that development projects would be doomed to failure if it were not for the initiative of implementers who take actions which go beyond prescribed plans and procedures. There is nothing novel or startling about this conclusion except that most development planning and administration rests on a completely contrary set of assumptions, i.e., that all obstacles can be foreseen and that local initiative is neither required nor even desirable. It is rare to find project plans which give attention to developing implementing organizations capable of making rapid adaptation to local circumstances.

The reason so little attention is given to organizational variables in development planning is because of the view of decision processes implicit in most project planning technologies. This view derives from what Steinbruner calls the *analytic paradigm* (or model). A very different view which provides quite a different perspective on national planning and implementing processes is provided by the *cybernetic paradigm* (model). The analytic paradigm is a set of assumptions about how decisions *should* be made under ideal decision-making conditions. It provides the basis for the formal model of planning and administration which has dominated development administration efforts. It prescribes a decision-making methodology appropriate when complete information is available, all alternatives can be evaluated, and decision-making is relatively free from political and institutional constraints.

The cybernetic paradigm, by contrast, is a set of assumptions about how decisions are actually made by groups and individuals. It is a more powerful tool for analyzing and improving organizational processes. The two paradigms serve different purposes, although this fact is often overlooked. By taking into account these differences it is possible to develop an alternative model of planning and implementing processes which achieves a partial synthesis of the two paradigms. Such a synthesis provides a framework for developing the more *adaptive* organizational structures and management systems required by organizations engaged in social development.

The analytic paradigm and the formal model of administration. Under the analytic paradigm it is assumed that to reach an optional decision, the decision-maker will proceed through the following steps:

1. Assign relative preferences or utility values to alternative states of the world.
2. Identify a range of possible actions.
3. Conceptualize a set of possible alternative states of the world which might result from each course of action, and assign values to each state.
4. Assign probabilities to each alternative state as a basis for predicting the consequences of a given course of action.
5. Combine the probability and value calculations to determine the action which has the highest expected return. This is the choice.
6. Continually update outcome calculations as new data become available.

The most carefully articulated models of this analytic decision process could apply only to an individual decision-maker; the barriers to extending their application to any kind of collective decision-making are formidable. In instances where decision-making by several parties is in-

involved, the usual practice is therefore to assume a decision-making entity which acts as if it were a single person, as if it could assert objectives and calculate strategies in their pursuit with the intellectual coherence of a single human mind. In the model of development administration based on the logic of the analytic paradigm, the function of the unitary decision-maker is assigned to a national planning office. It is presumed that the planners, a technically trained intellectual elite, will draw on a wide spectrum of data and research to identify policy options. Using formal analytic techniques they will assess the anticipated costs and benefits of each option to arrive at an optimal choice. This choice is then formalized into a program presented in the form of budgets, staffing tables and procedures. This is passed to Weberian-style bureaucratic agencies for implementation. The assigned role of the implementing bureaucracy is only to follow instruction, not to engage in analytic calculations of its own.

The bureaucratic system itself is supposed to insure adherence to procedure. Consequently its goals are set, and its performance is then evaluated on the basis of proper performance of prescribed activities rather than the accomplishment of results. Training teaches the procedures. Organizational lines of authority emphasize affinities between those responsible for similar procedures to ensure standardization; supervisors check on compliance with procedures. Feedback consists of providing reprimands when procedures are not followed. The entire system is designed to maintain central control by encouraging uniform compliance, thus minimizing adaptive behavior. If the implementing bureaucracy acts according to plan, some changed state in the program's environment (i.e., a planner's goal) is anticipated, such as improved health, increased contraceptive practice, or increased farm income. An objective outside evaluation group is commissioned to determine whether or not the bureaucracy's action, after a suitable period of time, has in fact produced the intended change. This information is then processed and passed to the planners, who update their choice of the next prescribed action accordingly.

This, in simple outline, is the model of the policy process and its supporting organizational structures which has dominated the development field, and generated the criticisms discussed earlier. While this described process represents an ideal toward which many planners strive, and while *elements* of the process are pervasive in the real world, examples of the complete *cycle* are difficult if not impossible to find. A basic weakness in the model stems from the fact that the tools of the planners are not sufficiently powerful to handle the range of data, action possibilities, and complex value orderings called for by the model. As a result, their analysis is at best partial. Also, data on social structures, administrative capacity, and the needs and desires of the common people are generally neglected altogether.

In the real world actual decisions are made through political processes, and are based on all sorts of things--which may or may not include the analyst's conclusions. While there are exceptions, most often the implementing organizations prove to be weak or inoperative, their members dispirited and disinclined to exercise the initiative required to overcome inevitable barriers to plan implementation. When there is adherence to the plan, it is likely that the plan will prove inappropriate to local circumstances and therefore ineffectual in reaching intended results. Evaluation is at best an uncertain process, because it assumes the capability to establish causality among a range of variables which are complex, interdependent, and often difficult to measure; it is hard to know why observed results occurred. Even where some reasonable evaluation data are produced, it may be expected that there will be a lag of at least three to five years between the time a project is initiated and the time at which outcome data can be collected, analyzed and transmitted. By this time priorities and possibly even the government will probably have changed sufficiently that the data are largely of historical or scholarly interest.

Does all this mean that rational decision-making has no place in managing the development decision process? Not at all. What it does mean is that while rational decision analysis may be a useful tool for improving the judgments of individual decision-makers, *the organizational model which follows from it is inherently unworkable in addressing all but the most routine of governmental activities*. And *routine* is what the tasks of social development are *not!* As a result the model is in effect attempting to force decision-making processes into an inherently unworkable mold. A look at the cybernetic paradigm helps make it clear why this is so.

The cybernetic paradigm. The cybernetic paradigm provides the basis for a descriptive model of organizational decision processes. It is organized around two central assumptions: that individuals make decisions based on short-cycle information feedback, and the elimination of uncertainty. The decision-maker is presumed to be continually watching a small set of important variables that are feeding back information from the outside world. For example, a medical supervisor might monitor the number of patients seen per hour by the doctor in a health facility. When the condition of one of these variables moves beyond acceptable limits (say, the number of consultations drops to less than three per hour), some action is taken. The choice of action seldom depends on an explicit analysis of the situation. More likely it will be a programmed response based on patterns of habit (the supervisor may send the doctor a letter of reprimand). If the variable then returns to an acceptable condition (say, four consultations per hour), no further action is taken. If it does not, the action is taken again, with modification (a stronger letter); or a back-up behavior in the programmed sequence is tried (a telegram). This process reflects the desire to reduce uncertainty: 1.) Attention is focused on only a few variables, with other information screened out (such as whether additional persons seek medical attention). 2.) Serious calculation of probably outcomes is avoided (such as the possibility that the reprimand will lead to generation of false reports). 3.) Actions are confined to familiar and tested responses (sending reprimands) which, if nothing elese, provide written proof that "action was taken." The process does not necessarily produce desirable outcomes, but it does provide a relatively accurate description of typical decision-making behavior in bureaucratic systems.

Unlike the analytic paradigm, the cybernetic paradigm can easily be used to analyze the behavior of multiple decision-makers within an organization. Furthermore it suggests an approach to increasing the capacity of groups to deal with complex environments while maintaining a simplicity for the individual decision-maker: by increasing the number of decision-makers, each is able to focus on a limited set of concerns, but all are linked together through formal organizational structures.

The cybernetic paradigm focuses attention on the *processes* rather than the *techniques* of decision-making. It highlights the inadequacy of any organizational model which presumes that major policy decisions either can or will be made by an all-knowing central decision-maker on the basis of "rational" economic calculations. The "decisions" which emerge from complex social systems are a result of the mutual coping and adaptation of multitudes of decision-makers throughout the system, each attempting to address his own definition of organizational and personal purpose within the context of a changing environment. This perspective suggests that the primary concern of those who would influence policy should be with the adjustment of the regulators which control the dynamics of decision processes throughout the relevant organizations. This adjustment process is known as *meta-management* and will be discussed below.

Within the cybernetic model both planning and implementation are inseparable parts of a short-loop adaptive feedback process, and it becomes inappropriate to make a clear organizational distinction between them. Planning becomes a continuing part of the management process, with different planning functions being carried out by responsible persons at different organizational levels. General policy directions are developed as part of a competitive political process. Just as planning is not a separable activity confined to a specialized unit, neither is evaluation. Evaluation is integral to the "cybernetic" process of monitoring key indicators and responding to those that vary beyond acceptable limits. Every active decision-maker in the system must be involved in it one way or another. If these decision-makers are ineffective in planning and evaluation functions it is because the organizational system was not properly designed.

Toward a Synthesis: A Rational-Adaptive Model of Organization

A major barrier to the success of social development efforts might be overcome by putting the analytical organizational model to rest. In its place can be offered a new normative model, a rational-adaptive model, which combines modern analytic techniques with advanced organizational design concepts. It suggests a focus on measures which will increase the collective rationality of large groups of individual decision-makers' actions within a cybernetic type of decision process. There are two premises:

First is the presumption that choices will seldom be taken solely on the basis of formal analytical studies; and they will not be made by a single independent decision-maker.

Second is the presumption that, while much behavior in organizations is routinized, with limited search patterns, it is possible to increase the rationality of individual actors, and thereby the adaptive capacity of the organization. This is accomplished by introducing training which helps these actors see new action possibilities, and by organizational systems which encourage more varied problem-solving behavior.

The approaches to improving system performance offered by the rational-adaptive organizational model are rather different from those suggested by the conventional formal model. These approaches rely on the idea of building problem-solving teams throughout the organization, able to act within broadly defined policy guidelines to achieve high levels of performance responsive to local needs. To facilitate this, key systems are designed to the following specifications.

- Goal setting and performance feedback systems must be designed to encourage decision-makers at all levels to focus their attention on performance indicators. Attention must be given to determining which performance indicators, whether quantitative or qualitative, are most consistent with overall program objectives, and to designing the system which will economically generate, compile, and communicate the required feedback in useful formats to the appropriate persons.

- Training must be based on problem exercises typical of the problems actually faced by persons in the program or organization for which the trainees are being prepared. The training must develop skills in problem identification and solution in personnel at all levels.

- Organizational designs must emphasize affinities among those who must work as a team to produce results. This requires capability in the analysis of tasks and job assignments to determine the appropriate teamwork configuration for the particular tasks to be performed.
- Supervisory practices must support adaptive behavior at lower organizational levels. This often requires a redefinition of supervisory roles.

The techniques of formal analysis can be brought to bear within this framework, using the preparation of formal analyses intended to provide analytic input to decision-makers representing different interests. The specific steps to be taken should include the following:

- Technical units should be established throughout the system to provide analytic support capacity to key groups of decision-makers.
- Linkages should be strengthened between analytic and decision-making functions.
- The system should be structured to provide the decision-maker with adversary analyses supporting different positions.
- Analytic methods and outputs should be simplified to make analysis more understandable to decision-makers.
- Professional analysts should be trained to give attention to issues of organizational capability and design, social output and distribution, and interest group preferences in their evaluation of policy options.
- Decision-makers should be trained in the use of economic, social, and organizational analysis, both to use the contributions of specialized analysts and to increase their own analytic skills.

The basic concepts of the rational-adaptive model have achieved a high level of sophisticated application in some of the more advanced business enterprises. There is a great deal to be learned from this experience; but the public sector manager faces a great many different constraints which may necessitate substantial adaptation of the management technologies developed with the private sector. There is a particular need for more knowledge of the change process in the public sector, and of the requirements of specific applications of technologies based on the rational-adaptive model.

Meta-Management: The Design of Decision Processes

Discussion of the requirements of social development points to a very important proposition: *if development strategies are to change, then the processes by which the society makes development-related de-*

cisions must change. Therefore, a crucial responsibility at the highest levels of any government seeking a social development strategy must be to assess and reorient these processes in ways appropriate to the requirements of that strategy. Such assessment and reorientation have been labeled *meta-management.*

"The fundamental concept of meta-management may be described as an endeavor toward influencing problem-solving processes within the system, rather than an attempt at 'finding solutions to problems' on behalf of the system," (Raymond Bauer, 1972). While it has been looked at most closely in relation to the functions of the highest management levels in large multi-business corporations, the concept of meta-management has major relevance to the highest levels of the public sector as well. In business, the growth and diversification of corporations has meant that top management can no longer make decisions directly for each component business, but rather must regulate the decision-making systems within which these decisions are made. Similarly, the growth and diversification of national governments has meant that major national departments or ministries which may once have directly controlled their own operating programs must gradually delegate direct authority over these programs to local bodies and assume the role of system regulator. The total society and its component economic, political, and cultural institutions become the relevant unit of concern to national level public meta-managers.

The reasons this transition is needed are much the same in government as they are in business. In large complex systems central authorities cannot possibly maintain sufficient expertise in all facets of system operation to make intelligent decisions for individual subunits comprising the system. They are too far removed from the data; and they also know that if the actions taken centrally were sufficiently contrary to the views or understanding of the subunit management they would in practice be ignored or subverted. Thus central authorities must seek more indirect means to shape the direction of the system and its components by shaping the decision processes by which their direction is determined.

Meta-managers exert influence over decision processes through their attention to structural variables, especially organization, information systems, and reward systems; and through making the judgments about individuals on which appointments to key decision-making posts are based. Brilliant analyses of economic and technical problems are seldom of as much concern to meta-managers as are people and ideas. Viewed from this perspective, the fact that one often finds that the major concerns at the highest levels of government are with people, power, process, and control of rewards, rather than with sophisticated economic and technical analyses, may not be so perverse as it might otherwise seem. The technical tools of policy analysis *are* more relevant to the concerns of intermediate and lower level policy-makers than to the very highest policy levels.

Distribution of power and the resolution of conflict are the consuming concerns of meta-management as they are a pervasive reality in large diverse social systems. Richard Normann suggests that in the business context, ". . . *meta-management's possibly most fundamental task is to see that the company has a satisfactorily functioning internal political system.*" Likewise it might be said that possibly the most fundamental task of the public meta-manager must be to see that the society has a satisfactorily functioning political system. If committed to social development, then we must see that this system provides for active participation of the poor.

The development of a capacity for meta-management must be a major priority of those concerned with social development. It is often presumed that what top policy-makers need most is more training in project analysis, PERT, and other techniques used by the professional planning technicians. To train them in the processes of political mobilization, and structural and bureaucratic reform, i.e., the skills of social-development-oriented meta-management would be more relevant. Indeed it can be argued that the professional planning technicians located in national planning units could also increase their effectiveness substantially from a grounding in meta-management, and revise their roles accordingly.

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The Transferability of Western Management Concepts—A Fourth World Perspective

Jon R. Moris

[Training in Western management methods has produced disappointing results in much of Africa. This article explores some of the missing prerequisites for Western-style efficiency, a lack which stems from the colonial era. (Note. The term Fourth World is used here to mean the poorer developing countries.)]

If we define the management process in Western terms as "the activity of planning, initiating and controlling the activities of other people," and if we assume (as many do) that the organizational techniques accumulated in the West over recent decades render this process a rational and efficient instrument for achieving organizational goals, there would appear to be a clear case for the direct transfer of these techniques into non-Western contexts. It is, after all, in the poorest nations where resources are most scarce that the attainment of organizational goals is most important for the survival and well-being of the society.

Let us define more explicitly the basic ingredients of our Western management concepts and programs that allow us to refer legitimately to them as a coherent tradition. Certainly, "Western management" does not possess a substantive unity as an intellectual discipline, a common body of agreed principles. What is it then that we have to transfer? Most authors accept a certain minimum definition of the scope of Western management:

a. It is about hierarchical organizations
b. with formal structure and internal specialization
c. which have defined tasks

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d. realized by the employment of rational techniques
e. of Western origin
f. designed to maximize efficiency.

But this sort of definition, of which there are many variants, can be quite misleading when utilized as a justification for the direct transfer of Western management concepts and programs into non-Western settings.

We owe an intellectual debt to comparative administration theorists for making clear some of the assumptions implicit in the above model. First, "rationality" and "efficiency" are attributes of organizational action that are determined not by the techniques themselves but rather by their manner of employment within larger contexts of organizational activity. For example, the use of elaborate cost-benefit techniques where data are unavailable, true costs unknown, and benefits cannot be measured can hardly be defended as a rational and efficient exercise. Second, by definition, management involves the employment of managerial techniques in a social context: the surrounding administrative culture is just as vital to effective management as are the specific techniques, if not, indeed, more vital. Third, the paradox we face in so many ex-colonial nations is that some of the greatest managerial barriers consist of administrative traditions *originally derived from the metropole itself*. To view such systems as being fundamentally non-Western is historically incorrect.

Our image of "management" as being *Western*, *rational* and *efficient* is probably a better indication of our needs within Western society than it is a tool for the comparative analysis of other administrative systems. For example, the notion that Western management is intrinsically rational strikes many non-Western observers as strange, since to them the patent irrationality of many of our arbitrary procedures is strikingly obvious. Similarly, in stressing the great efficiency of Western management, we easily overlook the coexistence of other, deviant forms of management within the West (some highly effective examples being the criminal Mafia organization, and the Daley political machine in Chicago), as well as entire bureaucracies (the Italian case), which embody irrationalities that would otherwise be judged as "non-Western principles."

Management, in contemporary business parlance, is a peculiarly American invention--and a fairly recent one at that. Like the computer, it has emerged rapidly through a sequence of specific responses to practical organizational needs. It is not accidental that this tradition has traveled most successfully on the back of American business and military ventures: with MacArthur to Japan, with SHAPE to Germany, with ITT to Latin America, with the multinationals to Britain and Spain, with the oil firms to OPEC countries. In all these cases, the effective transfer of Western management depended upon a massive accompanying cultural penetration, for some countries virtually the Americanization of whole sectors of their economy. Given such support, the Western management techniques have appeared to yield "rational" and "efficient" results in some non-American contexts.

However, much of the Fourth World experience (excluding the OPEC countries) indicates that the mere export of management techniques by themselves remains problematic--a form of transfer likely in the longer run to be neither effective nor perhaps desirable. Partly, the error comes from the widespread but unproven assumption that management is principally a matter of skills: a sort of craft that can be taught in any cultural context, and hence subject to export in much the same way as ox-plowing has been introduced in many societies on various continents. Partly, the error derives from our own fundamental naivete about "what makes management tick" in Western industrial societies. The standard textbook treatments of the topic abound in long abstract discursions on management functions, with chapters on "planning," "coordinating," "communicating," "delegating," and so forth. There is endless talk about *training* managers, as if all one has to do to become an effective manager is attend the right courses. But we don't really believe it, and neither do the companies--at least when it comes to the recruitment of their key managerial talent.

The African Exposure

The impetus for a rapid transfer of Western managerial training into African contexts arose from a convergence of opinion on both sides about the needs of new nations just after independence. The first priority in such nations was to replace the colonial administrators: either by rapid promotions of junior officials, which in Africa usually meant crash programs of short-term training, or by starting their own institutes for professional training, and usually by both. America had the universities, and the technical assistance funds, to satisfy these demands. In Africa, the assumption that managerial effectiveness is primarily a result of adequate training is not only unquestioned: it is one in which existing regimes have made an enormous investment. Most African nations show a rapid expansion of their top cadres. Thus, to challenge the efficacy of management training may seem to imply querying the rationale for Africanization itself.

Yet, at some point the issue must be faced: why is it that the transfer of Western management practice into Africa and Asia has had such disappointing results? Here, the simple answers are quite probably wrong. After bitter trial and error, one can only conclude that it is the system itself that is the problem, rather than the special conditions or people in one country or another. Working within such a system, one soon realizes that deeply rooted attitudes toward authority and assumptions about communication negate the intended impact of many Western managerial innovations. To the outsider, the origin of these obstacles within the colonial tradition seems obvious. Americans, however, fail to realize that this inherited ex-colonial system is finely nuanced and extremely complicated. Just as independence opened the door for the indigenous leaders to assume coveted positions of authority, so also much of the *esprit-de-corps* shared among senior officials derives from their patiently acquired expertise in making an arcane system jump through the hoops by dint of great effort. Challenges to the individual's established ways of showing deference are thus perceived as immediate threats to the established administrative order. For, in truth, it is no longer, for two or three decades, "the British" or "the French" or "the Dutch" system of administration; it is now fundamentally *the national system.*

Let us distinguish carefully between *techniques* and *administrative culture*. Techniques are by definition readily identifiable skills; and, as such, they are subject to transfer by training. They have been the object of virtually all "management training" that has been conducted in Fourth World contexts to date. Administrative culture, on the other hand, is the combined outcome of a long process of *informal work socialization*, and the interaction of complex administrative structures. It is much less readily amenable to direct transfer, perhaps hardly subject to programmatic transfer at all.

While we have little difficulty enumerating for export various promising managerial techniques (PERT, Management by Objectives, etc.), we know almost nothing about the structural prerequisites that underlie their effectiveness in the parent society. Nevertheless, it does appear that the transfer of at least some parts of this surrounding administrative culture is an essential precondition for the effective transfer of these techniques into other administrative systems. Examples of some of these crucial elements of American administrative subculture, whose lack in African contexts might help to explain the very weak performance of individual Western techniques, are as follows:

1. The interchangeability of organization resources (manpower, materials, plant, time, and money) for decision-making purposes.
2. Prevalence of an informal relationship of trust among managerial associates (in contrast to "zero-sum game" competition in which anyone's gain is always someone else's loss).
3. Acceptance of the costs of tying expensive facilities and resources to special purposes to ensure their availability at all times for those purposes.
4. Extension of accounting records as a control system impersonally to all aspects of an organization's activities.

5. Acceptance of internal decision rules governing operations as restraints dictated by technical requisites.
6. Acceptance of quantitative performance standards as a criterion of organizational health.
7. Existence of mechanisms that institutionalize the organization's intelligence separate from the person of individual officeholders.

The preceding listing could be extended for many pages; but at the least it should illustrate the interlocked nature of supporting assumptions that surround and render effective the individual management techniques. Such assumptions cannot be made the object of a training package; they reside in the individual attitudes of actors throughout the system as a whole. Obviously, if the individuals in Western management refuse to accept the money value of their time, do not observe arbitrary scheduling commitments, misuse tied resources, and demand a full demonstration each time technical constraints are imposed--our system could not work very well, if at all. And yet, from the standpoint of the individual actor in his proximate social and economic relationships, operation according to the preceding assumptions involves substantial private costs that in most non-Western societies would appear unnecessary and irrational.

Our problem in sponsoring the transfer of this tradition into other administrative systems has the following components:

1. Which of these background assumptions are crucial to the success of a given managerial technique (whose transfer is being planned)?
2. Which of these are reasonably congruent with the premises already being observed in the receiving administrative system?
3. Which other linkages between assumptions are a precondition for successful transfer?
4. What program contexts would appear to offer a congenial social setting for implanting and encouraging the whole corpus of managerial innovation necessary to make the transfer effective?
5. And, finally, is the transfer itself a desirable objective, given the complexity of the necessary supporting arrangements?

Some Hypotheses

There is an emerging consensus about the diagnostic features of Third World administration that appear problematic from the standpoint of the Western management tradition. Many of these features are not unique to Africa, Asia or the Fourth World in general, indeed some appear to be universal characteristics and shortcomings of any bureaucracy. However, the degree to which these factors are present, or the combined impact of factors present, can make Western management techniques inneffective in a Fourth World context. Here are some of the attributes various authors have noted:

1. Norms about hiring and firing may not be enforced, so that recruitment occurs only through personal influence. Security of employment is accepted as the norm of all levels, so that all who get in are safe.
2. The distinction between public and private goods is not always maintained, and, in varying degree, forms of corruption are common.
3. Tied resources are often diverted to meet urgent needs in other sectors; consequently, one cannot rely upon the availability and status of special equipment and facilities.
4. While governments' efforts are directed toward acquiring new facilities, capital and equipment, the maintenance of existing equipment and facilities is poor. Depreciation rates are roughly double those for the developed world, sometimes more.
5. Officials show marked ambivalence about technical matters. On the one hand, they may be sufficiently uncertain of their understanding of the issues at stake that no actions are taken. On the other hand, they often suspect deep down that technical constraints can be used as a pretext by the colonialists--now replaced by the Western experts--to embarrass them.
6. Professional norms may be poorly enforced, and professional "standards" are widely suspect as artificial devices designed to block the entry of indigenous nationals into such fields.
7. There is an intense internal politicization of the junior officers, who line up beneath various patrons in the hope that they may thereby gain advancement and recognition. Whom one knows and not what one does is regarded as the key to personal betterment. Distrust of one's associates and subordinates is common, and everyone remains highly sensitized to the power implications of each change of leadership and office.
8. When faced by a lack of enforceable sanctions, the top officials use the transfer of subordinates as a solution to almost every problem. Consequently, officials are constantly being moved around the country within the bureaucracy. Problems having to do with corruption or personality are not solved, but merely exported.
9. Within the administration, while downward communication is facilitated and expected, lateral communication tends to be

forbidden and upward communication of a personal nature not sought.

10. Top officials find it difficult to delegate responsibility for decisions. Higher officials operate in a condition of chronic overload, while subordinates are underemployed.
11. There is a flexible attitude toward scheduling. Almost everybody assumes that nothing ever happens quite as planned; therefore, departures from schedule are to be expected, and occur.
12. There is a flexible attitude toward plans, which are viewed as paper commitments mirroring a certain situation in power relationships at one point in time. Power relationships and circumstances change; and consequently so does the urgency of carrying out mutually agreed actions.
13. In administrative actions, the personal relations of everyone concerned are of paramount importance. Disagreement over issues is tolerated, but never if expressed in public; that would be interpreted as an attempt by the junior official to advance his own personal position vis-à-vis his superior. This situation leaves no room for rival views based on technical expertise.
14. The administrative system frequently lacks the capacity for organizational memory, making it difficult to learn from past mistakes. Planning and coordination techniques remain personal to the leader in power, so that the institutionalization of these key functions cannot develop.

If there were a country where all of the characteristics listed above could be found simultaneously, then it is hard to see how a western management approach could be successfully implemented. However, no national system displays all of these features. Indeed, they may be universal--found in all administrative systems to some degree, and in all countries. Nonetheless, in certain Asian and African situations a number of these weaknesses can be found in an accentuated form: especially in the smaller resource-poor countries; in the field administration far from the provincial or national levels; and in the professional fields like agriculture or medicine or education in which the contrast between performance standards and what can actually be realized with a paucity of equipment becomes extreme.

If the above delineation of common bureaucratic weaknesses has any validity, it does suggest at least three main implications. First, these attributes of bureaucratic behavior have a particularly virulent effect in the context of the public professional services. For example, in medicine and in agriculture, any tendency of other officials to regard technical norms as being dramatic devices without substance has immediate negative consequences within the field programs. The achievement of common tasks by the field units is greatly complicated by the internal polarization of roles between professional versus regular administrative cadres.

Second, a majority of the above weaknesses are of *systemic* origin. That is, they express the aggregate choice of actors spread throughout the system; hence, they are not subject to easy alteration by individual actions, even when new recruits with different predispositions enter the system. Why then does the system not collapse from its own internal weaknesses? The answer is that while the above traits are "weaknesses" from the standpoint of the assumptions underlying administrative effectiveness within the Western managerial tradition, these same traits become organizational *strengths* in a social system. This helps to explain the extraordinary persistence of traditional bureaucratic forms under adverse conditions. The system retains the capability to perform certain social functions effectively, so that viewed from within, the organism appears in normal health.

Third, the prospects for achieving an effective transfer of Western managerial practice into such systems by training alone (or, for that matter, direct capital assistance such as the World Bank gives) appear slim. More "high-level management training" would not appear promising until we can specify what it is about these systems that seems to destroy the efforts of their own best men. Why are capable men in such societies so often frustrated in their endeavors, and why are so many well-intended efforts having so little field impact?

Some Causal Relationships

Adequate answers to this central question depend heavily upon one's diagnosis of the particular causes responsible for the administrative patterns caricatured above, as do also one's prescriptions as to where in this system transfer efforts should be directed. Let us take a second look at some of the more likely explanations.

First, it is undoubtedly true that much of the present fabric of administration reflects strands woven in the colonial situation: represents, indeed, the predictable consequence of such experience, and is not surprisingly found almost everywhere throughout the ex-colonial Third World. In comparison with their home-based equivalents, the colonial officials retained most critical functions--planning, coordination, and control--in their own hands at the top. Initially, of course, they had no alternative; later these distortions had been subsumed already into the usual functioning of the administrative structure. There were new stresses when almost all top managers were replaced after independence, a gigantic experiment in very difficult circumstances, whose success is a tribute to most ex-colonial regimes. Some argue that the administrative system has been the most stable and successful feature of post-independence Africa.

Second, management has been the missing function in the education of the service professionals (doctors, agriculturalists, engineers, and resource scientists), just as rural development has been the missing sector in management education. There would appear to be much scope for enlarging the actual managerial content of such training.

Third, the extreme situational constraints affecting Third World administration can certainly explain some of its limiting features. The lack of educated manpower, of communication facilities and office supplies, are among the obvious deficiencies. Observers from the industrialized nations tend to ignore the cumulative impact upon the system as a whole of acute scarcity of most basic and critical components of a supportive infrastructure the West takes for granted. This is most evident in the poorer, socialist nations.

Fourth, the above circumstances encourage the "hub-and-wheel" pattern for managerial control. The fastest and most efficient managerial tactic in the colonial situation was for the individual officer to provide all the complex and abstract functions of administration himself. Any complex task was reduced to a set of rudimentary and specific instructions, which the "center-post" official could then pass individually to a ring of poorly trained subordinates, each of whom bore only limited responsibility not requiring much lateral communication (i.e., the spokes of the wheel). By dint of great effort, he was sometimes able to achieve quite remarkable results, considering the scarcity of resources and the unreliable quality of subsidiary staff. On simpler tasks, requiring mainly one-way communication, the "wheel" pattern of communication is perhaps the most efficient form.

Nevertheless, despite its stability and apparent successes, it has numerous long-run weaknesses if employed as the structural basis for all kinds of task integration. For one thing, the motivation and involvement of the subsidiary actors (the rim of the wheel in our metaphor) remain low. All the experience, power, and satisfaction accrues to the center-post position, none to the periphery. This structure does not perform well in situations where problem-solving is required, and where two-way communication is necessary. It seems to forestall the possibility for large-scale activities, since the pattern does not allow for much internal delegation and specialization beyond the first steps of task assignment. When the center-post man becomes old, or is promoted, there will be nobody beneath capable of assuming his functions; someone else in his image must be found, and the whole cycle repeats itself.

This pattern for task accomplishment was characteristic of the best colonial officers; it was also, incidentally, Henry Ford's preferred mode of action within his vast automobile company. The tendency to continue this form of administration as the predominant mode for control is strongly reinforced in contemporary Third World settings. The "wheel" communication pattern is congruent with the prevailing conceptions of authority in many areas. Thus the administrative system's extreme structural resilience grows out of the substantial access to power that these minuscule hierarchies offer to a fairly large minority of actors (the center-post occupants) who hold the many senior positions interlaced at all nodes throughout the highly differentiated network. For them, administration is an exciting and rewarding experience. Furthermore, almost everyone controls and gives orders to somebody else except at the very bottom level. We should not forget, however, that one-person-controlled companies still exist in the Western world, and some of them compete quite effectively with even the largest corporations on certain types of tasks.

The preceding comments are hardly exhaustive. The resource-poor tropical countries of Africa seem to share a common style of administration that is neither entirely non-Western, nor fully explicable in terms of each country's unique culture heritage. Furthermore, this pattern of administration has shown sufficient resilience to render ineffective many externally induced managerial innovations. But we should realize that these "weaknesses" have, paradoxically, rational causes subject to analysis and informed action. At a minimum, a comprehensive understanding *from the inside* of how these systems work would seem to be an essential starting point for future attempts at managerial innovation in Fourth World contexts.

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A "Negotiating Model" in Integrated Rural Development Projects

Eric J. Miller

[Neither a "top-down" nor a "bottom-up" approach to rural development is wholly satisfactory. This article proposes the alternative of a negotiatory relationship between government and rural villagers, and examines the ingredients of its successful application in a Mexican project.]

Efforts at rural development in Third World countries have generally not been crowned with success. Indeed, for some "beneficiaries" the results have been disastrous. For example, peasants who have been persuaded to abandon subsistence farming for a single cash crop such as cotton may prosper for a while, but two or three successive years of infestation or depressed world prices can force them off the land. In other cases the innovation just disappears and the peasants return to the *status quo ante*. Large numbers of rural drinking water systems, for example, which are proudly inaugurated as a contribution to villagers' health and welfare, are out of use within a couple of years, apparently because the local communities lack the skill or will to operate and maintain them.

Our response to these failures has been to move away from isolated crop improvement projects or health projects towards programs of integrated agricultural development and, in a few countries, integrated rural development. Such a program involves a wide range of interventions and investments in farming technology, rural industry, credit, commercialization, road-building, transport and other areas, designed to bring about economic advancement; and alongside these, projects concerned with nutrition, health, housing, education, and so forth, intended to improve the quality of rural life. On paper,

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at least, this "total system" strategy looks capable of bringing about the massive transformation that is required; and on paper, too, the achievements can seem impressive in terms of the numbers of wells dug, hectares irrigated, schools built, and so on. But all too often in the process of implementation the concept of integrated development gets lost. Objectives are confused; methods are inadequately worked out; government agencies find it easier to compete than to collaborate; officials are incompetent or corrupt. As a result, the experience of the recipients is often of isolated and even capricious actions, which seem unrelated to each other or to local needs. Programs such as these therefore risk becoming more elaborate and costly mechanisms for producing the same failures as before.

The Government of Mexico introduced its integrated rural development program known as PIDER in 1973. It was a large and ambitious undertaking, ultimately intended to reach some 20,000 rural communities with 300 to 3,000 inhabitants each. Between September 1973 and November 1976, I worked as a part-time consultant to the Directorate of Public Investments, which was the division within the Ministry of the Presidency responsible for establishing and administering the program. Initially, the Directorate was seeking advice on the major organizational problems posed by the program, which called for the coordinated intervention of many different federal ministries and agencies at state and local levels. Since organization is a means of carrying out a task, we had to consider what the task of the program was. Each agency had its own specialized activity--roadbuilding, rural electrification, irrigation, soil conservation, setting up village health centers, and so on--and all of these could be seen as potentially contributing to rural prosperity and welfare. But the critical word is "potentially." These new installations and projects were no doubt necessary conditions for development, but they were not sufficient conditions. They would contribute to development only if the rural communities themselves were able to use them and build on them. At that stage, therefore, I saw the task of the program as "to procure a self-sustaining process of rural development." The problem was to identify the kind of relationship, at the interface between the "developers" and their "client systems," that would enable this to happen, and then to provide the conditions for the developers to take up appropriate roles. This was my main preoccupation over the next three years.

From my initial discussions in Mexico City and visits to the field, it rapidly became clear that, sometimes explicitly but often implicitly, two conflicting models of the development process were operating. These can be summed up as "top-down" (Model A) and "bottom-up" (Model B). Seldom did they appear in practice in a pure form, and indeed the same individual might seem to oscillate between them--perhaps voicing a Model B philosophy while acting on Model A assumptions. However, the confusion was not only his: he was expressing something of the multiple and conflicting objectives of the rural development program that are familiar in Mexico and elsewhere. At the risk of stating the obvious, the distinctions nevertheless seem worth spelling out.

Model A: Top-Down Development

Increased agricultural production is a significant objective in all national programs I know of. The document stating the objectives of the Mexican program was careful to point out that this was a means of enhancing rural prosperity rather than an end in itself; but not all the participating agencies would regard this as a meaningful distinction. Increased production is certainly a national objective--in order to feed the growing urban population, reduce imports, and earn foreign exchange from exports--and it is an explicit part of the mandate of the Ministries of Agriculture and of Agrarian Reform. That, then, is the message that these ministries' officials, experts, and extensionists carry with them when they go into the field. They tend therefore to behave as if the primary task of the program is to develop and organize rural communities so as to meet national production goals. From this it follows that the local community and the population of peasant farmers within it is conceived as a subsystem within a national production system.

There is a close analogy here with a commercial holding company seeking a return from its investments in subsidiary companies. And indeed it is noticeable that this formulation of the objectives is associated with the application of principles of scientific management to community development: typically, attempts are made to organize each community according to a standard type of democratic, participatory system that requires a collective structure, election of office-holders, division of labor, definition of functions, delegation of responsibilities and authority, and use of incentives. An underlying assumption of Model A is that there is a substantial consistency between governmental economic objectives and rural community needs. National programs to achieve these objectives will benefit communities by increasing their prosperity. The orientation is technocratic: the experts know what needs to be done. Accordingly, any resistance displayed by the communities is irrational: with education and persuasion they will come to see that their own self-interest coincides with the national interest.

Model B: Bottom-Up Development

It is always a stated objective of rural development programs to rectify gross inequalities of wealth; and one does not need to be a Marxist to recognize that much rural poverty (though by no means all) is a consequence of historical subjugation which has generated demoralization, apathy, fatalism, and submissiveness. People are trapped in a cycle of deprivation from which they feel incapable of escaping and have given up trying; they do not perceive themselves as having any choices. Following from this diagnosis, the primary task of Model B can be stated in some such terms as these: "to restore the self-confidence that will release energy and motivation for self-development," as stated by Paulo Freire (Cultural Action for Freedom, 1972). His starting-point is a process of adult education which enables the peasants to examine and question the situation they are in. They learn that their impotence is a consequence not of inherent inferiority but of historical processes. These are reversible. Government aid is not a privilege that they should feel grateful to receive, but something they have a right to demand, even to fight for. In effect, the postulate is that they need to engage in something equivalent to revolutionary activity in order to regain a sense of potency and thereby to release energy for constructive self-development. Model B can slide imperceptibly into revolutionary activity for its own sake: where the conflict of interests becomes total, the primary task is to destroy the oppressors.

Neither Model A nor Model B was operating in a pure form within the PIDER program. What I discovered from my discussions and field observations in 1973 and early 1974 was that there were more signs of the top-down than of the bottom-up model, but that in fact one could identify the emergence of a third model, which was a kind of compromise between them. Official program policy listed the following criteria for selecting investment projects:

1. Highest priority should be given to productive projects which guarantee large-scale permanent employment...
2. In the social field, the drinking water, health, education and housing projects should foster a positive change in way of life and, still more, a necessary change of attitudes.
3. Priority will be given to complementary projects which strengthen the profitability of investments already made.
4. In all cases an attempt will be made to satisfy the needs expressed by the people, and projects will be carried out only at the explicit request of the communities.

Elsewhere in this policy document, issued in April 1973, there was emphasis on promoting participation, "so that a mechanism can be established which permits planning from the bottom up." Community representatives were to be involved not simply in planning local developments but in the design of regional strategies.

The intentions sounded admirable; but unfortunately a development program is influenced less by good intentions than by the structure and culture of implementation. Usually there is strong pressure to act, and to act quickly, as if inequities that have been condoned for generations should now be put right overnight. The dilemma of the Mexican program, as of others, was that although the importance of inculcating an ethos of community self-development was recognized, the very process of undertaking a large and rapid investment in productive projects and amenities tends to put the community in a dependent posture, a posture which is antithetical to self-development.

Model C: Enlightened Paternalism

The model actually in operation can best be described as "enlightened paternalism." The strategic unit for development with the program was a "microregion." This would be identified on the basis of ecological and socio-economic uniformity and *prima facie* evidence of developmental potential. The average population was 75,000, and so it might contain 50-100 communities eligible for investments under the program. An interdisciplinary team of some 20 members, drawn from the various agencies involved, would make an intensive tour of the microregion. Each community would be visited, perhaps for half a day, in order to survey its resources and needs and to identify possible projects. Towards the end of the visit all the men in the community would be assembled, and the team would outline the projects it had in mind and ask for comments and alternative suggestions. Essentially that was the moment of participation. The team would subsequently assemble all the data from the field visits, devise an overall strategy for the microregion, make preliminary estimates of sums to be spent for various types of investment (e.g. road-building, soil conservation, fruit-growing), and then select the most deserving projects under each heading from the total range of possible projects that had been listed originally. These recommendations then had to be approved both by the headquarters of their respective agencies in Mexico City and by the central organization of the program itself. It would be at least six months later that the community would be told what projects, if any, had been earmarked for it.

Sometimes the microregional strategy had a discernible coherence; but often it seemed more like an aggregate of projects. At the level of the community, any concept of a development plan was rare indeed: investments and interventions seemed arbitrary and often unrelated to each other or to priorities that the local population itself might have set. It could be said that the "developers" were behaving as if the primary task of the program was to demonstrate the Government's good intentions. Their relationship to the communities was that of benefactor to beneficiary. They came equipped with a gift-list of projects that they could carry out, sometimes quite competently. Although they paid lip-service to the idea of bottom-up planning, this was for the future; in this initial phase the recipients were perceived as incapable of assessing the options open to them or of choosing among them.

Such arguments had some validity. It takes time and skill to help a community to formulate its needs. Many peasants were distrustful of the Government: promises had been made in the past but never translated into action. Donation of, say, a drinking-water supply can give a community a feeling that it is being valued and help it to acquire some self-confidence. However, in some ways the integrated program was putting the beneficiaries into a more extreme position of passive dependence than some more conventional development projects that had been administered by individual agencies. Rural electrification schemes, for example, had required that part of the costs should be borne by the communities that benefited; and this encouraged each community to organize itself and to acquire some identity as a client system. Under the PIDER program such contributions were waived, and an incentive to organize was removed. The benevolent paternalism of Model C was therefore tending to hold the communities in the passive-dependent posture, and was doing little to encourage them to move into the more active, autonomous, entrepreneurial posture that was necessary if they were to become capable of self-sustaining development.

Model D: A Negotiating Model

My proposal was that the program needed to move towards a "negotiating model," which was in fact more consistent with its intentions. My thinking can be summarized as follows: Essentially the top-down Model A and the bottom-up Model B are both in a way right; the search for areas of consensus and compromise between them, implied in the enlightened paternalism of Model C, while it may have been necessary to gain sanction for the Program, was not the best solution for development. A Model D that overtly recognized divergences as well as commonalities of interest would be developmentally the most productive. The fact that a community comes up with an assessment of its own interests which does not match the assessment that a governmental agency has made does not mean that it has either to be blamed for its irrationality or praised for asserting its independence: it is simply a fact, and a predictable one at that. Correspondingly, the observation that the governmental agency is trying to implement policies that do not find local acceptance does not imply that one should either criticize it or sympathize with it. Although the Federal Government acts with the ultimate authority of the people in the service of the people, it will not please all of the people all the time. These facts, then, are not to be swept under the carpet: they are matters for examination and for negotiation. It is through such a process at the interface of community and agency that the peasant begins to find the meaning of his role as a citizen of the Republic, and begins genuinely to participate in planning for development; while the agency members for their part begin to question the relatedness of federal policies to local concerns. Both parties learn from the transaction. Assumptions get tested and modified. It is a process, in other words, that gives some reality to that over-used slogan, grass-roots democracy.

The primary task of Model D could be defined as "to provide resources to help each community to formulate, negotiate and implement its own community development program." The first element of the model, then, is a community development program formulated by the community itself. This requires making available a consultancy resource through which the community can become aware of the possibilities for change. However, in designing a strategy for itself the community will need to take into account the development programs of neighboring communities and of the administrative district of which it forms a part, and the policies and resources of relevant Government agencies. So we have as a second element the concept of joint planning and programming. These lead to, third, the negotiation of a contractual relationship between the government and the community, in which each party undertakes to contribute resources to the community development program that has been negotiated.

Much of my work as consultant to the program from 1973 onwards was directed towards shifting from Model C to Model D. A fundamental change was required in the relationship between agency representatives in the field and the client communities. As I have indicated, these representatives were seen, and to some extent saw themselves, as benefactors; the community was the recipient of bounty. The agency representatives had the resources; the community had none. The representatives had the power to give or withhold projects according to their picture of whether the recipients could make effective use of the investment in them; the community had no control over this process. The transaction was one in which the situation was totally defined by the agency representatives while the community remained in a passive and dependent role. My observations revealed, however, that the authority and power of these officials in the field were mythical. The real power lay with their agency superiors in Mexico City. Indeed, the relationship between these superiors and their field representatives corresponded almost exactly to my description of the representative-community relationship. My proposition was that the administrative system, and the nature of these representatives' authority or lack of authority within it, had a determining influence on the nature of the development process through which the representatives related to the client communities. Unless the field representative could exercise authority in negotiation (instead of having to refer all decisions to his superiors), the community was unlikely to discover its own capacity to do so. The same applied to relations between agencies: to expect that the peasants would organize themselves for collaboration was hardly realistic so long as the participating agencies themselves had not learned to work together toward a shared objective.

Besides helping to introduce specific organizational and administrative changes that would push or pull authority outwards from the center to the field, my role had an educational component. I was trying to teach my clients about systems. The task of the development process, as I saw it and still see it, is to produce robust self-managing systems.

Any potential intervention has to be evaluated for its systemic consequences; and, as the negotiating model suggests, the nature of the relationship between development agency and client may be more significant for development in this sense than the content of specific projects. In this I was challenging the conventional wisdom not only of Mexican government agencies but international funding bodies, such as the World Bank and the Inter-American Development Bank, which, even in an integrated rural development program, call for an economic cost-benefit justification of each project and insist on the lowest-cost alternative. With such requirements one should not be surprised at the number of rural health centers which look impressive in the statistics but remain unused.

Ingredients of Successful Projects

With or without the benefit of my advice, the program was expanding rapidly. By the end of 1975 about 5,000 communities all over the country had received or were in the process of receiving investments under the program, and with some there had been contact for two and a half years. We had here a large-scale natural experiment in which it was possible to generate and begin to test hypotheses. As a start, I paid three short visits over the next few months to regions where the program was said to be showing signs of "success." The criterion I adopted was that there should be evidence of people beginning to manage their own development and, in particular, of reinvestment. For example, in one village, where a workshop provided employment and several cooperative poultry-keeping projects had been introduced, some of the income had been reinvested; but, more importantly, it was being used to finance new productive activities through purchase of cattle and of sewing-machines to make clothes for sale as well as for family use. In addition, a percentage of profits from poultry-keeping was paid into community funds, which were being applied to a children's playground and new public buildings. In another case, in order to provide permanent employment for landless laborers who had worked on road-building at the beginning of the program, a small sawmill was built with a contract to supply posts for rural electrification. This generated a substantial surplus which, with the agreement of the workers, was used to seed further rural industries. A collective organization was formed, and in little more than two years it had set up nearly 200 small enterprises providing about 1,500 new jobs. Control of the individual enterprises and of the corporation as a whole was vested in the workers, who were mainly women and girls.

From these and other cases it was possible to identify some common factors. Characteristically, a PIDER representative had exercised leadership in getting a client group to visualize a desirable and attainable future state, and to commit itself to taking the first steps toward achieving it. He had sufficient authority (sometimes reinforced by political power) to commit contributions from the program, but these usually took the form of materials and technical assistance. The clients were expected to contribute labor to and often manage construction and other activities. He and/or members of his team were in frequent contact with the client group; this seemed to have an important function in sustaining the vision of the future before there were any concrete achievements. Thus there was a good deal of dependency, even charisma, in the early phases, but this was not a source of self-depreciation by the clients. The leadership role had been so managed that the hope and potency invested in it had been routed back to the clients in the form of a growing belief in themselves and their own capacity to bring about changes. They themselves were taking initiatives--taking over the vision, as it were--to which the representative was able to respond flexibly on behalf of the program. Explicitly or implicitly, the criterion he used was whether the proposal would enhance the clients' capacity for self-management; and so he might use program resources to back projects that would not always stand up individually to a stringent cost-benefit analysis. (He seemed to have the freedom to do this partly because of the savings obtained through high participation of clients in earlier projects.) Management and initiation of projects had required a repatterning of existing organizational arrangements in the client system or the emergence of new structures (such as the collective corporation). Finally, the changes in internal structuring seemed to be directly related to and contingent on changes in the relatedness of the client system to its external environment.

I found that these brief field studies had sharpened my insight into underdevelopment and therefore the processes of development. Underdevelopment could be defined operationally as a relative lack of control over relations with one's environment, where that includes both the local physical environment and the external environment that comprises the wider socio-economico-political system. Specific aspects of these relations--economic and other--can be identified, analyzed and sometimes measured. Development, then, implies a change in such relationships in the direction of influencing and controlling the environment, instead of being controlled by it--a change from impotence towards potency. Following from this, I could assert much more unequivocally that *the primary task of a development program is to help the client system to increase control of its environment*. That furnishes the criteria for effectiveness; that is the task for which the development agency needs to organize itself.

Four aspects of this task may be identified. Two of these are familiar enough; but I suggest that the significance of the third, and, in particular, the fourth is insufficiently recognized.

The first aspect is development of the human resources of the community. It is obvious that education can inculcate new techniques and skills; literacy gives access to alternative values and goals. Similarly, improved nutrition and health can release greater energy for existing and new activities.

The second aspect is enhancement of the physical resources of the community. This is the objective of many development agencies, which, as we have seen, often measure their performance by the number of wells dug, health centers constructed, households provided with electricity, etc.

However, as with the example of drinking-water systems, installation is not synonymous with utilization. These projects, therefore, are to be regarded only as means, not as ends in themsleves. The criterion of effectiveness lies in my third aspect: have they helped the community to extend its control over its physical environment? An extentionist may work hard and successfully to arouse enthusiasm for a new agricultural technique, which really seems to be moving the boundary between the farmers and their physical environment; but after two seasons of successful operation with markedly higher yields, the farmers regress to previous methods. Sometimes this is simply because the extensionist has failed to ensure that supplies of the requisite seeds and fertilizers will be readily available. Sometimes it is because he has misjudged the goodness of fit between the innovation and the prevailing culture. Extensionists may also ignore the pragmatic wisdom of peasant communities that has enabled them to survive. (P. R. Jennings, Scientific American, Vol. 253, No. 3, 1976.) They are not interested in crops that produce a very high yield but only in good years; the varieties they have learned to trust are those that will minimize the chances of a total crop failure in the bad years. But often the most plausible explanation in such cases is simply that the farmers have not acquired the skill to manage the new process themselves; they have been dependent on the extensionist, so that only his continuing presence has permitted the innovation to be sustained.

So I come to the fourth aspect: that the community will not achieve greater control of its local physical environment, or the achievement will not be sustained, unless the change is also accompanied and reinforced by corresponding and more permanent changes in relations with the external environment. The community also needs to become more autonomous and influential in managing these relationships. Many of these changed relationships will be economic: for example, the community sells produce instead of exporting manual labor; it sells its produce in processed form instead of selling it unprocessed (for example, cheese instead of milk); it diversifies its products; it extends its control over distribution and so commands higher prices; and so on. Obvious though these points may seem, it is surprising how often they are missed, even in supposedly integrated development programs. Extensionists promote higher yields without considering the process of commercialization, so farmers have little incentive to increase output if all the extra profits go into the pocket of the traditional middleman. Nor is a government purchasing agency always a viable alternative. R. Ackoff, writing on development planning in the Mexican context, cites cases of agency employees being bribed by the middlemen to reject farmers' offerings, which were then sold to the old buyers at depressed prices. (Operations Research, Vol. 25, 1977, p. 207.) Farmers may therefore need to be helped to establish their own cooperative marketing arrangements, bypassing the middleman, if they are to get a proper return.

Along with such economic gains, a less obvious, more subtle and more significant change seems to occur: a change in the community's identity and self-image. As a result, for example, of bypassing the old channels and managing distribution themselves, the people acquire a different--more potent--image in the external environment, and this in turn reinforces an emerging image of themselves as more potent, both collectively and individually. In one of the villages mentioned above, several different family enterprises were engaged in poultry-keeping. Among themselves they organized their production cycles so as to maintain a steady overall output, and in the market of a nearby town they manned a stall to sell the dressed chickens. The stall bore the name of the village and quickly acquired a reputation for quality and reliability. This in turn helped to sustain the collaborative arrangements, and was quite evidently a source of pride and added self-confidence in the village as a whole. In this way, technical and structural changes become confirmed by a cultural transformation. The outcome, then, is a system that has discovered the possibilities of exercising autonomy and choice and has become capable of managing itself in a self-sustaining process of development.

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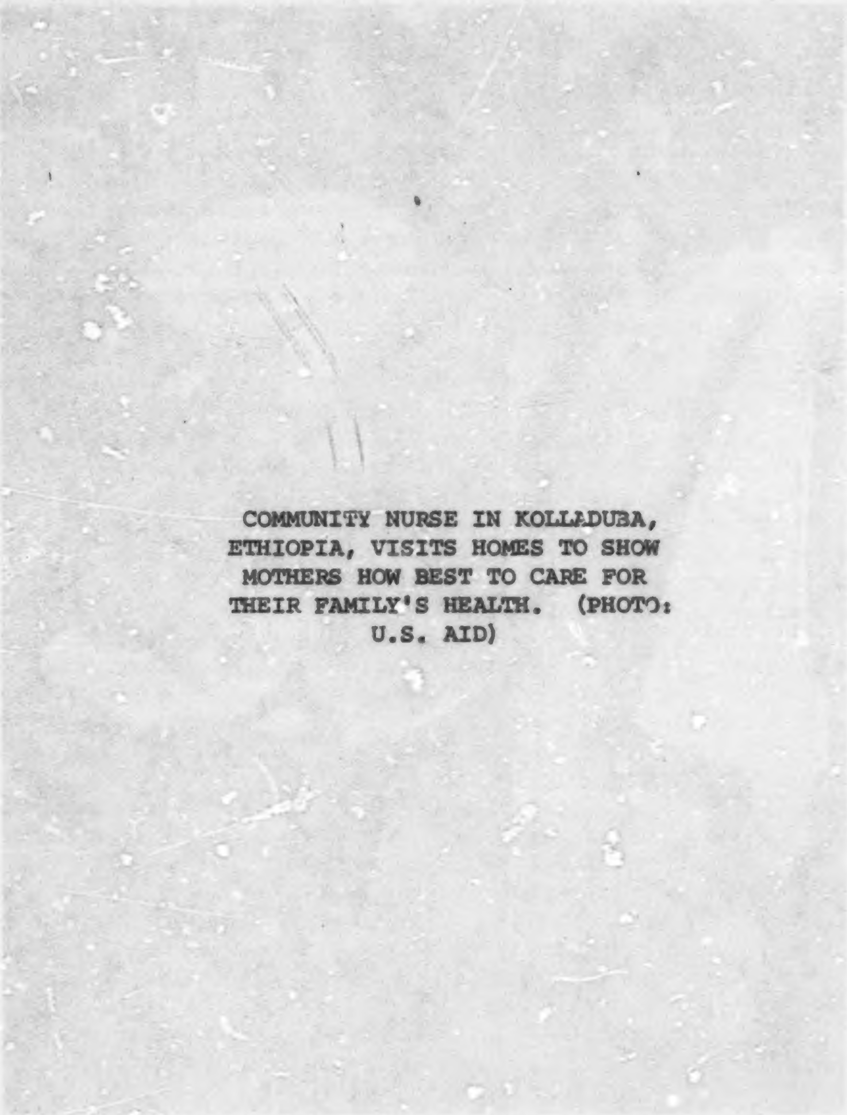

COMMUNITY NURSE IN KOLLADUBA, ETHIOPIA, VISITS HOMES TO SHOW MOTHERS HOW BEST TO CARE FOR THEIR FAMILY'S HEALTH. (PHOTO: U.S. AID)

The Role of the Community Health Worker in Primary Health Care

World Bank Staff

[The provision of adequate health care in developing countries encounters budgetary, administrative, cultural and a myriad of other problems. Increasingly countries are turning to Community Health Workers (CHWs) as a means of extending health services to underserved areas.]

A key element of primary health care, or of any health care system that attempts wide coverage at relatively low cost, is the use of community health workers (CHWs) with limited training, both to provide front-line services and to refer seriously ill patients or special cases to larger dispensaries and hospitals. The potential duties among which their time must be allocated are maternal and child health care, midwifery, family planning, treatment of injuries, and helping to move seriously injured people to referral facilities. In addition, they may organize immunization and mass treatment programs, provide guidance on nutrition and hygiene, as well as monitor epidemics, water quality and sanitation.

China illustrates the fact that widespread primary health care is feasible even for low-income countries, although it makes heavy administrative demands. An effective coordinated approach is needed--involving careful selection and training of CHWs, thorough supervision, referral of serious cases to better trained and equipped people, and adequate (but controlled) availability of drugs and other supplies. Without this, CHWs are likely to become demoralized, discredited and

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inefficient--and their recommendations for curative and preventive care disregarded.

Moreover, the emphasis that many current reports give to primary health care should not detract from the importance--or understate the difficulty--of striking the right balance between community level activities and the back-up system that provides referral services and supervision. Rural health centers, urban clinics or small rural hospitals should deal with various illnesses that are beyond the scope of a CHW. These should come under the umbrella of a referral hospital with laboratory, x-ray facilities, an operating room and beds. Depending on population densities, transport, and incomes, such a hospital could serve 100,000 to 250,000 people and oversee the activities of three or more clinics and about 50 CHWs.

Lessons of Experience

National experience with primary health care systems is still very limited. The Chinese barefoot doctors date from the mid-1960s. During the 1970s countries as diverse as Iran, Brazil, Sudan, India, Jamaica, Botswana and Tanzania began large-scale systems. Their experience has shown which are the key requirements of success.

- Political support and finance. It is vital to secure the support of a substantial share of the country's "health establishment;" without this, sound medical supervision and adequate finance will not be possible, and primary health care will be little more than an empty gesture toward the poor. It is also important to ensure that this type of medicine is not mislabeled as "second rate."

The CHW should work cooperatively with the community, if possible through such recognized organizations as the local council or village development committee--as in Botswana and Sudan. This builds community support and increases chances of improving family health practices; hours of service, use of drugs and materials, and patient satisfaction can also be monitored. The community organization should have access to the supervisor of the CHW.

At least part of the CHW's salary should be paid by government so that health officials can retain some control. But some local finance or voluntary efforts also make the CHW responsive to local concerns--and in turn can make the community more aware of the services offered. The government of India is providing a stipend of 600 rupees a year ($76) to "volunteer" health workers. Whether local pressures work in the interests of the poor depends on the degree to which the local political system reflects these interests. China has succeeded in making the community entirely responsible for compensating the CHW. But overreliance on local finance may mean that the poorest communities get the worst attention.

- Recruitment and training. The CHW should be mature enough to enjoy the respect of the community. Early programs stressed formal education as a qualification for the CHW, and thus recruited young people. Reviews of experience in Sudan clearly indicate that such people are not easily accepted by communities. Ideally, the CHW should have children and personal experience with health crises. Programs now recruit highly motivated older people, even if younger applicants are better educated. The CHW also should live in the community; this has been found to reduce turnover as well as ensure familiarity with local culture. In some countries, such as Iran and Yemen, it has been necessary to train both a male and a female CHW because of objections to treatment by members of the opposite sex.

Community health workers must be given enough training, equipment and supplies to ensure that only one patient in four or five is referred to higher levels. High referral rates undermine the community's confidence in the CHW and also increase the probability of patients bypassing him or her. This conclusion has been confirmed by studies in Mexico and Thailand. Moreover, several countries feel that CHWs should have the chance to develop their careers by competing for entry into higher grades. Sudan, for example, is planning to confine its "medical assistant" training programs to CHWs.

- Supervision and supplies. Frequent supervision of the CHW is essential. The isolated, modestly trained CHW is rarely confident of his or her skills and often encounters difficulties that instructors did not anticipate. Supervisors should both provide in-service training and ensure that performance meets minimum standards. Iran, Sudan and Botswana have found that under-supervision risked undermining the confidence and credibility of the CHW. Workers should be visited regularly by staff from neighboring dispensaries, health centers and hospitals as well as from the office of the regional medical officer. This compensates for frequent transport difficulties or competing demands on the supervisor's time. In addition, it ensures that a broad range of issues --from clinical care to drug management--are considered, and that visits from the outside are regarded as routine, not part of a crisis.

Providing facilities for telephone or radio contact between CHWs and supervisors has provided backup and helped avoid unnecessary referrals in Honduras, for example. Physicians or highly trained health personnel often give curative work priority over supervision of CHWs--so nontechnical personnel should also play a part in the supervision and monitoring of CHWs.

A standard, simple set of drugs should be provided to CHWs; if budget cuts are necessary, they should not fall on medicines and supplies for the CHW (as has sometimes been the case). Standards are required for the use of drugs and supplies; and the drugs provided to individual

CHWs should be monitored to identify misuse or misappropriation. Kenya has developed a model program for managing drug use, based upon carefully devised treatment standards.

Other Considerations

Higher-income countries can afford to reduce the ratio of persons covered per hospital and clinic, and to staff and equip them better. But even in industrialized countries, there is a strong trend toward more emphasis on paramedical workers to improve the spread and effectiveness of basic health care and to help keep costs down.

In many countries it is also desirable to make use of, and provide some training for, traditional health practitioners, such as "ayurvedics" in South Asia and the traditional birth attendants found in almost every country. This is partly because they often have the trust of their patients and because patients pay for their services--enabling government funds to be spread farther; but it is primarily because in many countries, including some of those where the world's poor are concentrated, these practitioners provide near-universal coverage of people who, realistically, will not be reached by effective government health programs for some time to come. Training can help them to improve their treatment, dispense some modern medicines and participate in health or family planning education.

In addition, there is still an urgent need for research to develop measures to prevent or treat common disabling diseases--for example, malaria, schistosomiasis and the main causes of diarrhea in children--that are simple and cheap enough to be applied within the framework of a primary health care system.

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The Village Health Worker Program in Afghanistan

Steven L. Solter and Peter N. Cross

[This article describes the questions of policy and operation encountered during a program for training and placing health workers in villages in Afghanistan, and the answers that were found for these questions. While the program was cut off before long experience had accumulated, the issues that arose are of interest for other countries.]

The Afghan Ministry of Public Health (MOPH) first considered the idea of village health workers (VHWs) in the fall of 1973. Early discussions between high-level MOPH officials and AID advisors suggested that the only way Afghanistan could provide accessible primary health care to the majority of its population living in 23,000 villages, many of them very remote, was by training large numbers of VHWs. But this was not an idea easily acceptable to senior Ministry staff.

Most high-level Ministry officials at that time were urban physicians who had had relatively little experience with village health problems. The central idea of the VHW--that villagers choose someone from their village with minimal education to be trained in a brief course in a nearby basic health center (BHC) and return to the village to treat common medical problems and provide basic health education--was a concept foreign to Afghan doctors and Ministry officials and was not immediately welcome. Gradually, as the Chinese "barefoot doctor" became better known, as Afghan Ministry officials were invited to international conferences on village health workers, and as WHO's position supporting primary health care became clear, the atmosphere in Kabul grew more supportive of the idea. The MOPH also realized that the major international donors (AID,

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WHO, and UNICEF) were firmly committed to extending health care to villagers through the use of VHWs.

Thus, in the spring of 1976, the Ministry and AID decided to support several "experiments" in creating an alternative health delivery system. A survey conducted in Baghlan, Ghazni, and Helmand provinces in 1976 documented the degree of interest; of the 723 villagers interviewed, 90 percent felt that a VHW program was feasible for their own village. Most believed that villagers themselves should select their own VHWs. The majority of respondents also felt that VHWs should be literate and could be either male or female. Although the survey results did not seem to interest most MOPH officials, the fact that the great majority of villagers supported the idea of VHWs was useful information for those few individuals in the Ministry who were interested in the program. Once the MOPH was convinced that a VHW Program should begin, it sought and obtained approval from the Afghan cabinet in April of 1977 for a program to train 1,500 VHWs thoughout the country by 1982. These 1,500 VHWs would provide basic coverage for about 10 percent of the rural population; for full national coverage some 15,000 would be needed eventually. Funds for training, per diem, supplies, and each VHW's initial stock of drugs would come from UNICEF; technical assistance was provided by AID.

The first group of eleven VHWs completed training May of 1977; between that time and January of 1979 when the program ended, a total of 137 VHWs were trained. The new pro-Soviet government that took power in Kabul in April of 1978 decided to eliminate the VHW program for political rather than technical reasons. New advisors urged the Ministry to stop training workers similar to the Chinese "barefoot doctors." They argued that health workers similar to the Soviet *feldshers* should be trained instead. Even though *feldshers* were inappropriate for providing health care to Afghan villagers since they came from the city, were not chosen by the villagers, and were based in fixed health facilities at a great distance from many villages, the MOPH decided to accept the Soviet advice. In September of 1978, there was an International Conference on Primary Health Care (sponsored by WHO and UNICEF) held in Alma Ata, U.S.S.R. The leader of the Afghan delegation was the Deputy Minister of Health, an inexperienced 26-year-old nephew of the then Foreign Minister, later President, Hafizullah Amin. Prior to the Alma Ata meeting, the Deputy Health Minister was a strong public supporter of VHWs; when he returned from the meeting, he was determined to destroy the program.

This, then, is the short history of the training of village health workers. Although the program's termination prevented the results of this effort from being observed for very long, many of the issues arising and their solutions are of interest.

VHW Program Development

How would the VHWs be chosen? It was generally agreed that VHWs would be selected by their villages, but there remained several options as to guidelines for selection. The MOPH could insist that all VHWs chosen by villagers *must* be already practicing traditional healers. This would have two advantages: if only indigenous practitioners could become VHWs, then Afghan doctors would be less likely to oppose them, because their training would merely enable them to do better that which they have already been doing anyway. The second advantage would be the fact that villagers were already visiting them for health reasons, and their upgraded status would simply help them be more effective in changing health habits. There would also be disadvantages in requiring VHWs to be former traditional healers. For one thing, it would greatly limit the freedom of choice of villagers. In addition, traditional healers could be reluctant in many ways to make fundamental changes in their practices; a barber who has made his living by doing minor surgery for 30 years may not readily adjust to a different philosophy of health care.

The second option was to allow the villages complete freedom to choose anyone they wanted to be their VHW. This, of course, could result in close relatives of village leaders being chosen, but it would allow villagers to take a more active role in making those decisions which affected their lives. The third alternative was to strongly suggest to villagers that a traditional healer be chosen as their VHW, but not make it compulsory. Also considered a strong contender for the VHW role was the local village shopkeeper, or *dokhandar*. The *dokhandars* knew how to maintain their supplies, were centrally located, were open long hours, and could be trained to give health advice and sell basic drugs for common conditions.

The MOPH finally decided to leave the ultimate VHW choice completely up to the villagers.

Setting minimum qualifications. Several issues had to be clarified before rational minimum qualifications for VHWs could be determined. First, if the villagers were responsible for selecting their VHW, then any minimum qualifications set by the MOPH would interfere with the villagers' freedom to choose. However, if each village chose whomever it wanted without paying attention to minimum standards, was there then a risk that the *Khan's* feeble-minded son might be chosen? Without a requirement for literacy, for example, each VHW class might consist of both literates and illiterates, greatly complicating the training process. This fundamental dilemma was resolved by the MOPH by providing guidelines but respecting the final decision of the village even if some of the guidelines were violated. The major guidelines were that the VHW should be:

Functionally literate;
Older than 18 years;
If male, finished with his military obligations;
Able to spend at least 4 hours per day as a VHW;
Accepted by all major factions in the village;
Dedicated to serving his fellow villagers;
Intelligent and honest;
Respected by his fellow villagers.

Another crucial issue concerned the sex of the VHW. Ministry officials concerned with establishing a VHW program recognized the fact that a female health worker was more likely to influence village child-care and child-feeding practices (as well as contraceptive behavior) than would a male health worker. However, the female VHWs might not be allowed to leave their villages for training, were not likely to be literate, and being illiterate would not be good candidates for providing basic drugs (Afghan physicians were likely to violently oppose illiterate village females distributing any kind of drug whatsoever). The MOPH at first considered allowing literate female VHWs to have drugs, but there were too few literate village women available. Instead, the Ministry decided to train men as VHWs in the areas of basic curative care, environmental sanitation, and personal hygiene and to simultaneously train traditional village midwives (*dais*, who were largely illiterate) in the areas of maternal/child health (MCH) and family planning. In this way, a basic team consisting of a VHW and a *dai* could provide the essential primary health-care services at the village level, easily accessible to the great majority of the population.

Skills and competence: It was important to define the context in which the VHW would function in order to determine the skills and competencies he or she should possess. Since the major health problems of the village were considered to be preventable morbidity and mortality in children under 5 (as well as uncontrolled fertility), blamed partly on certain long-standing unhealthful habits, it was felt that a trained VHW could be most effective by trying to encourage changes in these habits. Some of the most important practices and beliefs that the Ministry felt were detrimental to village health are listed below:

- Infants were usually fed only breast milk until 24 months of age, with little supplementation.
- Infants and young children with diarrhea were not rehydrated by their parents.
- Sick children were usually given inadequate fluids and not fed properly because of traditional beliefs concerning diet and disease.
- Any flowing water was considered safe for drinking.
- Most villagers did not wash hands with soap and water

prior to preparing food, before eating, or after defecating.

- Flies and feces were ubiquitous and constantly contaminating food and water.

Based on these observations, it was clear that the VHW curriculum would have to stress practical approaches to health education, nutrition, personal hygiene, and environmental health. In addition, VHWs would have to be able to provide effective contraceptives (for the first time in any Afghan government-supported program) as well as basic drugs for common complaints. Another essential would be to distinguish those patients whom the VHW could treat in the village from those patients needing referral to the BHC. Underlying all was the importance of the VHW serving as a model by practicing those health habits which he or she was telling others to practice.

Training was fixed at 3 weeks (6 hours per day, 6 days per week), but only after substantial debate among MOPH officials. Several officials contended that if the majority of Afghanistan's 23,000 villages were to have a VHW within a reasonable period of time, the length of training would have to be kept to a minimum and the cost held down. They argued that a 2- or 3-week period was long enough for the essential skills needed to substantially reduce preventable child mortality; further training could be given later in the form of short, intensive continuing-education courses. Others, however, suggested that in order to persuade Afghan doctors that VHWs possessed minimal skills, a longer period of training was essential. They felt that a villager who had had a limited education (4 years, for example) and who had completed his education in a village school 10 years before would need a certain minimum time to become adjusted to completely alien ways of thought. Many VHWs would probably have been indigenous practitioners in their villages, and it takes time to train such workers to be able to effectively combine traditional and modern medicine. The final decision, favoring the short course, was based primarily on the overwhelming numbers to be trained and the very limited resources with which to accomplish such an enormous task.

Drug-dispensing--would VHWs dispense drugs? A major area of disagreement was the potential impact of this decision on the opinion of Afghan physicians. Some MOPH officials felt that a few key drugs (such as oral penicillin or a glucose electrolyte mix for diarrhea and dehydration) could be lifesaving in remote villages where bacterial pneumonia and dehydration were leading causes of death in children under 5 years of age. They argued that without such essential drugs, the likelihood of the VHW having a significant impact on child mortality was minimal. Villagers were mostly interested in drugs for the relief of illness; a VHW whose capabilities were limited to advice on how to live in a healthy manner would be ignored, even shunned. These officials suggested that VHWs who could provide basic curative care for common conditions would be much more influential in changing harmful health habits than would a VHW who was not able to treat those who came to him or her.

An opposing group within the Ministry argued that if the VHWs were allowed to dispense drugs, this would be so threatening to the Afghan doctors (since the self-image of Afghan doctors is largely that of someone who prescribes drugs) that the program would be doomed. In addition, all drugs can cause side effects and complications; if a villager were treated by a VHW and the treatment were followed by some untoward reaction, the villager would blame the VHW and the program could become discredited. Furthermore, drugs must be continuously resupplied. If the MOPH has difficulty supplying 120 BHCs with drugs, how would it ever be able to supply 15,000 VHWs on a continuous basis? It would be better for a VHW to have no drugs than to have drugs initially only to run out of them later. A final argument of this faction was that to allow VHWs to prescribe drugs would mean that, in effect, the VHWs would do very little other than curative care, since the villagers would be far more interested in drugs than in health education and there would be almost no incentive for the VHW to provide any preventive services.

Consensus was finally reached to allow the VHWs to prescribe drugs, but whether they should give injections was an emotion-laden issue. It was recognized that villagers generally prefer injections to tablets, capsules, or syrups (the more painful the injection the better--if it hurts, it must be good); if the VHW were to have any status or respect in the village, it was essential that he or she be able to give injections. It also was recognized that nearly every village has an untrained injectionist whose technique is likely to be decidedly unsterile; if the VHWs did not give injections, then villagers would surely seek that service from the local injectionists. It was thus decided that VHWs should be taught how to give injections using sterile technique, although they should not be provided any injectable drugs by the MOPH. Only oral drugs would be provided to the VHWs.

Further debate led to the following list of drugs that VHWs could prescribe. All were to be prepackaged in course-of-treatment dosage packages.

- Tetracycline eye ointment (to be used topically for conjunctivitis and for the early stages of trachoma);
- Aspirin;
- Penicillin V (oral, to be given only when the patient had a cough and a body temperature greater than 38°C);
- Oral contraceptives;
- Piperazine (for roundworm infections, which are extremely prevalent in Afghan villages);
- Ferrous sulfate with folate (iron, for anemia, which is

particularly common in adult Afghan women);

- Multivitamins with iron (including vitamin A for xerophthalmia);
- Oral rehydration salts (a glucose-electrolyte solution for diarrhea and dehydration). Some VHWs also provided simple antacids and sulfadimidine.

These particular drugs were chosen because each of them was considered effective against conditions or problems that were an important cause of morbidity and/or mortality in the village and because each (with the exception of oral contraceptives) was quite safe, even when given in very large dosages. Even if a particularly avaricious VHW prescribed every different drug packet every day to everyone in his village, the resulting harm should be minimal.

The VHWs were unhappy with the fact that they did not receive an antidiarrheal drug. The glucose-electrolyte packets were for replacing vital fluids and salts lost from the body during an episode of diarrhea, but the could not *stop* the diarrhea. Afghan physicians prescribe antidiarrheals to young children with diarrhea (the favorite drug is Sulfaguanidine), and fluid and salt replacement are rately emphasized to the parent. Consequently, a large number of Afghan children die from dehydration, even after being seen by a physician. But if the VHWs had been able to dispense Sulfaguanidine routinely in addition to the glucose-electrolyte packet, it is likely that they would have dispensed only the Sulfaguanidine since that was the drug that the villagers were used to, and dehydration in children would have gone uncorrected. Similar discussions and arguments took place with regard to all the VHW drugs. Those selected for inclusion in the VHW supplies were felt to be appropriate, both at the start of the program and after 18 months of field experience.

Program financing: The VHW was not salaried by the Afghan government, but would be allowed to sell prepackaged drugs at a small profit. There was very little disagreement on this issue. MOPH officials shared the view that the government was not prepared to pay VHW salaries from its meager budget, and recognized that international donors are usually very reluctant to pay salaries except as a temporary measure. All agreed that the VHW should be compensated in some fashion for his or her work, but felt that this support should come from the villages.

The rural health surveys had revealed a startling fact, that the mean annual personal-health expenditure in rural Afghanistan is seven times the government expenditure. This meant that 87.5 percent of all money spent on health care in Afghanistan comes out of the pockets of poor villagers, representing 7.4 percent of the annual household income of the average Afghan family. Closer examination of this household health expenditure disclosed the importance of drugs to the Afghan:

37 percent of his health expenditure goes into pharmacy drugs and additional money on traditional herbs and medicines. The willing expenditure for drugs suggested a means of support for the new village-based health program.

Since villagers were interested in having a VHW, and since they were willing to pay for drugs, the Ministry decided that VHWs could sell their drugs at a small profit (2 Afghani or 5 U.S. cents per packet). A village could supplement this income--by allowing the VHW to charge on a fee-for-service basis or by asking each household to contribute a certain amount in Afghanis per month--but this was to be decided by each community for itself. It also was generally agreed that each VHW should have some other job or means of support, that being a VHW should not be a full-time job.

Profile of VHWs trained: Most of the VHWs selected by the village committees can be divided into three groups. One group consisted of young, literate, underemployed men who were sons or nephews of members of the village committee. A typical member of this group might be a 24-year-old son of a prominent *malek* (landowner). The *malek* had three older sons to work his land, but there was not enough land to support his youngest son as well. This youngest son was then selected to be a VHW, thereby gaining some prestige and a small income for this part-time job. The second group of VHWs included *mullahs* (Muslim religious leaders) and shopkeepers, who were usually literate and respected in the village. The third group consisted of literate men who had been indigenous practitioners of some sort, most often as injectionists, herbalists, or bone-setters. Most of the VHWs selected were genuinely interested in the job of VHW.

Overall, of the 137 VHWs trained during the life of the project, the typical worker was male (only six were female) and about 34 years old. (The youngest was a 15-year old nomad, while the oldest was a 57-year old *mullah*.) He was literate and had probably attended school for about four years. (Many elder VHWs had acquired literacy through informal teachings of the local *mullah*; one elderly VHW was a retired military officer with a degree from a military college.) Eighty percent of the VHWs were married, and 91 percent had completed their military obligation. Over half the VHWs were "farmers."

Response of the VHWs to training efforts. The VHWs were extremely eager to learn and seized the opportunity with great enthusiasm. Many had read all 150 pages of their textual material by the second or third day of the 3-week training program. By the end of the program, many VHW trainees had nearly memorized much of the material through continual rereading. They frequently kept trainers after class to discuss their village's health problems. It would be hard to imagine a more enthusiastic group of students.

There was, however, a difference between the younger and older trainees in their ability to integrate what they were taught and to use their new knowledge in their village work. Supervisory visits after training to older VHWs (particularly *mullahs* and shopkeepers and those who had been injectionists or indigenous practitioners) revealed that they had difficulty changing some of their health practices. Younger VHWs, however, while not having health beliefs or practices of long standing that were resistant to change, were not as well respected by their fellow villagers as were their older colleagues. Thus VHW recruitment and training faced a dilemma. If younger VHWs were trained, they were much more likely than older VHWs to follow the principles and behavior patterns they had been taught; but their health-education advice was not as likely to be followed. Since the villagers themselves made the final selection of VHWs, the VHW training teams had to do the best job they could with whomever the villagers chose.

Curriculum and training skills. Fundamental to successful VHW training was the development of a simple, appropriate training curriculum designed to train literate villagers. A set of three manuals was developed (in the Dari and Pashto languages) to assist the VHW in learning basic skills and in performing necessary curative and preventive tasks in the village. By using the manuals, the VHW could "look up" anything he was unable to remember.

For example, if a VHW saw a patient with an eye complaint, he could look up eye problems in either his Reference Manual or his Field Manual. The Reference Manual discussed, in a clear and simple way, what kinds of eye problems were common in the village and what could be done about them. The Field Manual, in a more specific and concrete way, stated when an eye patient should be referred to the BHC doctor and when such a patient could be treated by the VHW in the village. It also listed several key points necessary for the prevention of eye diseases in villages that the VHW should explain to the patient. In addition, it listed exactly what should be done about treating eye problems.

The VHW curriculum initially emphasized the training of VHWs to perform those skills listed in the manuals. The curriculum was divided into the following areas: maternal and child health (and family planning), environmental sanitation, personal hygiene, nutrition, introduction to the human body and germ theory of disease, first aid, curative medical care, immunization, and organization of the VHW's job. Principles and techniques of health education and of working with community leaders (such as the village committee) were stressed throughout the 3-week course.

Practical work was to be given the highest priority; it became the most serious problem faced by the training teams. The plan was that VHWs would spend much of their training time actually *doing* the things they would do on their own in the village, such as providing first aid, etc. But since the 3-week courses were conducted at BHCs, the trainers had to depend on patients at the BHC for all curative and first-aid teaching, and some BHCs had very few patients. If, during the 3-week course, no patients with burns or fractures came to the BHC, the VHW trainers were forced to teach the diagnosis and treatment of these conditions by lecture or demonstration using uninjured people. The training teams found, however, that by being imaginative with those patients who did come to the BHC, they could provide the VHWs with adequate practical training. Nonetheless, some VHW trainers were not very imaginative in making the training practical. They often preferred to lecture rather than to have the students actually practice those tasks which they would have to perform when they returned to their villages. This problem contributed to a decision to revise the VHW curriculum to help improve the quality of teaching practical skills to VHWs. The revised curriculum was completed, but the program came to an end a few months later.

The 18-month experience indicates that for a curriculum to be effective, it must be very specific and detailed; each point should be made clearly and distinctly, and examples of how that teaching point can be taught should be made explicit for the trainers. All trainers must themselves be trained in using the curriculum, preferably by both classroom teaching and on-the-job training. In order to use the VHW curriculum most effectively, the training teams, when in the field, must be able to purchase certain items (like locally available weaning foods) which are essential for teaching. The trainers must periodically have "refresher courses" themselves, so that their interest in the curriculum must be revised reasonably often, with the trainers providing the most important input. And finally, audiovisual and other teaching aids should be integrated with the curriculum in order to have the greatest possible impact.

Problems in finding an appropriate financing mechanism. After the Ministry decided to permit the workers to sell prepackaged drugs for a small profit (5 cents per packet) as well as to allow the village committees to decide on any other means of financial support for the VHW, it remained to be seen how this arrangement would work out in practice. Based on one and a half years of experience involving a total of about 130 VHWs, the following observations can be made.

None of the village committees were able to organize any system for financially supporting the VHWs. All the village committees were informed by VHW recruitment teams that they could allow the VHWs to charge a fee for service in addition to charging for drugs. The village committees also were told that they could require each household to pay a few Afghanis per month to supplement the VHW's income (as a kind of prepaid insurance scheme). When the village committees were visited at a later date and asked why they did not take these steps, the most frequent answer was that they were waiting for the VHW to receive a government salary. Despite repeated denials that this would in fact take place, most village committees rationalized their lack of financial support by insisting that a government salary was absolutely necessary.

The profit from the sale of prepackaged drugs, in itself, did not provide the VHWs with sufficient income to support a family. The average VHW sold no more than 100 packets per month, giving him a $5 monthly profit. Most VHWs, in addition, charged a small fee for giving injections and occasionally charged for providing first aid. Unless the VHW was able to earn substantially more money than this from some other job at the same time (such as farming or being a *mullah* or shopkeeper), he would have to quit being a VHW. What generally happened was that the men chosen to be VHWs either had no other job and had to be subsidized anyway by their relatives, or were relatively affluent and could spare the time to be a VHW in order to gain the status and prestige associated with the job. The complaint about receiving no salary was a persistent one, however, affecting VHWs and village committee members alike. At the time the decision was made to end the VHW program, a plan was under consideration in the MOPH to provide minimal monthly salaries to the VHWs, but they could not have been paid much under budget limitations.

The MOPH on several occasions considered increasing the profit per packet allowed to the VHW. However, when the VHWs in Jaghori were asked if they favored an increased profit, they said no. The Jaghori VHWs at that time had already been working as VHWs for a number of months and understood their financial situation quite well. They felt that some villagers in that very poor area could barely afford the medicine they were selling--despite the fact that the drugs they sold, supplied by UNICEF, cost the villager far less than the same drugs bought at a pharmacy. To raise the price per packet in order to give more profit to the VHWs would cause hardship. Also, such a rise in price would harm the very positive image the VHWs had acquired in their villages. The Jaghori VHWs might have reconsidered their decision at a later date, but they never had the opportunity.

Despite the frequently expressed fears of MOPH officials and others that the VHWs would cheat by either charging higher than allowed rates for their drug packets or else selling their UNICEF drugs to pharmacies at a big profit, there is no evidence to suggest that either was a common practice. Pharmacies sold the same drugs at prices 100 to 400 percent higher than what the VHWs were charging, and the pharmacies were usually located many kilometers from the VHWs' villages. This situation is ideal for a black market; it is certainly possible that had thousands of VHWs been trained instead of 137 such a black market would have sprung up. But as it happened, the great preponderance of UNICEF drugs

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were sold to villagers at the established rates. One reason may have been the fact that all the drug packets had labels clearly showing what prices were supposed to be. Also, the village committee had an interest in maintaining the correct price, since they benefited from the cheap prices along with everyone else. Finally, there were always few enough VHWs so that selling drugs to pharmacies could be fairly easily noticed and reported.

Curative care provided by VHWs. Village health workers kept a register book for all patients who came to them for curative services. Of 2,497 sequential patients seen by a sample of nine VHWs, the VHWs had recorded the problems of all but 109. Table 1 shows the frequency

TABLE 1

PATIENT PROBLEMS RECORDED BY VHWs

Problem	Definition	Number of Cases	Percentage of Cases	Seriousness[a]
1. Headache	Includes general body ache, muscular aches and pains, toothaches, earaches	246	9.8	NS
2. Eye problems	Except eye injuries	78	3.1	S
3. Pneumonia		20	0.8	S
4. Common cold	Includes "throat problems" that were probably sore throats	101	4.0	NS
5. Suspected tuberculosis	Includes cough (probably chronic) breathing problems, chest pain	34	1.4	S
6. Gastrointestinal problems	Includes abdominal pain, diarrhea, dysentery, vomiting, and worms	818	32.7	S
7. Weakness and anemia		344	13.8	S
8. Fever		309	12.4	S
9. Skin problems	Includes impetigo	42	1.7	S
10. Jaundice	"Yellow skin"	22	0.9	S
11. Injuries	Probably mostly lacerations and bullet wounds, many probably infected; excludes burns	164	6.6	S
12. Burns		22	0.9	S
13. Family planning		18	0.7	S
14. Injection		273	10.9	NS
15. Other problems	Deliveries (2), malnutrition (1), malaria (1), gonorrhea (1), broken bone (1), measles (1)	7	0.3	S
Total		2,498[b]	100.0	

[a] NS = problem probably not serious; S = problem potentially serious.

[b] VHWs had failed to record problems for 109 patients. Two problems were recorded for 108 patients. Three problems were recorded for 1 patient.

of recorded illnesses. It is encouraging to note that just over 75 percent of all the problems recorded by the VHW sample can be classified as probably serious. They do appear to have been providing a valuable service to the rural population they served. Table 2 presents the variety of services provided by VHWs with the frequencies of each in the period for which data are available. There appears to have been little demand for family-planning services from (male) VHWs. Of all the treatments provided by VHWs, only penicillin might on rare occasions prove dangerous; but the amount of penicillin used by the VHWs in this sample does not appear excessive, just over 5 percent of the treatments provided. This limited experience appears to support the initial decision to provide VHWs with penicillin; the benefits almost certainly exceeded the risks involved.

TABLE 2

RELATIVE FREQUENCY OF TREATMENTS PROVIDED BY VHWs

			*Patient Cost in Afghanis**	
Treatment	***Number***	***Percentage***	***Adult***	***Child***
Aspirin	**583**	**21.5**	**4**	**3**
Penicillin	**137**	**5.1**	**22**	**13**
Multivitamins	**317**	**11.7**	**5**	**5**
Oralyte	**141**	**5.2**	**10**	**10**
Iron	**122**	**4.5**	**8**	**4**
Piperazine	**658**	**24.3**	**6**	**4**
Tetracycline eye ointment	**81**	**3.0**	**7**	**7**
Sulfadimidine	**89**	**3.3**	**6**	
Oral contraceptives	**9**	**0.3**	**2**	
Condoms	**9**	**0.3**	**2**	
First aid	**232**	**8.6**	**(5)**	**(5)**
Nutrition education	**1**	**0.0**	**0**	
Referrals	**48**	**1.8**	**0**	**0**
Injection	**280**	**10.3**	**(5)**	**(5)**
Total	**2,707**	**99.9**		

***$1.00 equals approximately 40 Afghanis during the period in question.**

Note: Costs given in parentheses are subject to the whim of individual VHWs; these were the charges recommended to the VHW.

Preventive services. No hard data were collected on the ability of Afghan VHWs to deliver preventive services. The lack of any incentive system for VHWs to provide such services probably signals a major weakness in the VHW program as implemented. There was no financial support for the provision of preventive services. Villagers could not be expected to pay the costs because they did not perceive the need. For the government to have paid a salary to VHWs to do preventive work would have doomed the program to almost certain failure: the government's Basic Health Centers could not provide minimal preventive services to even the most limited catchment area despite relatively well-trained and salaried staff; the possibility of the government supporting and supervising preventive work by thousands of VHWs was beyond consideration. Nevertheless, attempts were made to impress upon the VHW the importance of prevention. More than 50 percent of the training hours were devoted to preventive concepts and services. In particular, the VHWs were trained to discuss prevention with patients every time they appeared with a curative problem.

It seems doubtful that the VHWs did much in the area of health education. Political events at that time interfered with the course of the program, and no follow-up was made. The AID team tried, on a very small scale, to develop a village water-supply program to be associated with the VHW. In Sarobi District, Ministry sanitarians, who were paid incentive per diems by AID, used UNICEF-provided materials and free labor donated by villagers (mobilized by the VHW) to construct piped gravity-flow drinking-water systems in two villages. Acting independently, and on the basis of their training, the VHWs may have had some effect on village water supply. At least one VHW was observed to have improved the spring from which his family got its drinking water, and several VHWs constructed sanitary latrines after their training.

The government's expanded Immunization Program was assisted in an immunization experiement using VHWs. Largely owing to the efforts of an exceptionally motivated sanitarian at the Sarobi BHC, the experiment was quite successful. Rural people are generally favorably disposed to vaccinations because of the successful eradication of smallpox. Over a thousand vaccinations were administered with VHW participation. It was the first time that either measles or polio vaccine had been administered in a rural setting in Afghanistan, but this was possible only because of one unusually motivated sanitarian.

VHW patient costs. Patient-visit costs are fairly easy to estimate from the information in Table 2. Assuming VHWs charged the recommended 5 Afghanis for injections and first-aid treatments, the average patient-visit cost works out to be 7.6 Afghanis, or approximately 19 cents. For patients receiving drugs, the average cost was slightly higher: 8.4 Afghanis per patient visit, or about 21 cents. This compares very favorably with the average cost of a visit to a pharmacy, as indicated by villagers in the 1976 survey noted above. There, the cost, including transportation, was 248 Afghanis, or approximately $6.20, nearly 30 times the cost of a VHW visit.

Three principal factors were responsible for the low cost of patient visits to VHWs. First, and probably most important, the VHW used generic drugs purchased via a revolving-fund mechanism through UNICEF at a small fraction of the cost of the brand-name drugs sold at pharmacies. Second, VHWs brought the drugs to the patients, minimizing patient travel costs. Third, the VHW's profit was only 2 Afghanis per prescription, accounting for only 26 percent of the cost to the patient; pharmacy markups are undoubtedly considerably greater.

Several other costs are not included in the preceding calculation. These are the program costs, that is, training costs, supervisory costs, start-up capital costs (cabinets, chairs, and other equipment, all provided by UNICEF), and program-management costs. The magnitude of these costs is a little difficult to estimate, but preliminary calculations indicate that training and start-up costs amounted to about $400 per VHW. If this cost is depreciated at 10 percent per year, and if one estimates the overhead costs (borne by the MOPH) at $60 per year per VHW, then the program costs amount to approximately $100 per year per VHW. Experience indicates that VHWs received about 450 patient visits, which is borne by the MOPH and foreign aid donors. The estimated total cost, then, is 19 cents (borne by the patient) plus 22 cents (borne by the government) to equal 41 cents per VHW patient visit.

Conclusion

Prior to the VHW program, the only regularly available providers of health care in Afghan villages were the indigenous practitioners. For certain ailments, most villagers clearly preferred "modern" medicine, which was available only at the nearest Basic Health Center or pharmacy, many located at prohibitive distances from their villages. The initial experience in training and supporting VHWs indicates that they can make an enormous psychological difference to remote village people. The VHW's certificate, framed neatly on the wall, reassures the villagers that the VHW training has meant something. The VHW's well-stocked drug cabinet within a 10-minute walk of most villagers means that when Mohammed Sadeq's son becomes suddenly sick and feverish at 3:00 a.m., there are effective "modern" remedies close at hand. The VHW's effect on village confidence and morale is positive, and until the program was terminated under external pressure it was perceived as a useful government contribution to the community.

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Traditional Medicine in East Africa: The Search for a Synthesis

Norman N. Miller

[Controvery rages over the potential role of traditional healers and the position of traditional medicine in health programs of the Third World. Kenya and Tanzania differ sharply on this question. This article examines the issues involved in synthesizing traditional and western medical practices in East Africa.]

> "African traditional medicine is one of the pillars of the cultural heritage of the Region . . . an integration of the two systems (traditional and Western), without compromise of principle, yet with full understanding on both sides, should enable the sorely underprivileged population to benefit from one of the fundamental human rights: the right to health."
>
> World Health Organization (WHO)

The issue of medical synthesis evokes vigorous argument. The debate is not on the inferiority or superiority of Western medicine in an African context. No one seriously denies the superiority of Western medicine for certain illnesses, particularly those demanding complicated surgical techniques. Rather the issues are poverty, high medical costs, difficulties of access to health care, questions of solace and mental health, and the inescapable reality that Western medicine will not be available to the masses for years to come.

Policies and Issues

The policies of Kenya and its neighbor Tanzania typify two very different approaches to traditional medicine. Officials in Kenya have denounced traditional healing for years, calling for local *mgangas* to give up their prac-

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tices. Cases of malpractice by "bush-doctors" are headlined in the press, and traditional healing arts are constantly confused with "witchcraft," "sorcery," and other "black arts." Only in recent months have there been signs that some sympathy for the traditional healers may be emerging.

Tanzania, on the other hand, permits the search for a synthesis. The government sponsors a traditional medical research unit, a major office/laboratory complex for traditional medical research is nearly completed, and a chair in traditional medicine exists at the University of Dar es Salaam. On-going research activities in herbal medicine in several regions indicate traditional healing has the status of a "quietly official policy." In both countries the debate is heated.

Political Issues. Neither Kenya nor Tanzania openly supports traditional healing for fear of encouraging exploitation, charlatanism, and malpractice. The "pro" and "con" camps include Western-trained physicians, health ministry officials, the press, politicians, traders dealing in herbs and drugs, the healers themselves and their entourages. Traditional medicine has many forms and reflects the ways of thought and life in the 165 ethnic groups of both nations. The goal of the "pro" camp is to restore traditional medicine to an honorable position. This, however, requires admitting that most practices are culturally differentiated, which is a counter-thrust to the political unity and integration embraced by national leaders. Different forms of healing or folk-medicine exist in each of the 123 ethnic groups in Tanzania and the 42 ethnic groups in Kenya. Some proponents argue that a synthesis of the core elements within each folk system should form a "central" East African traditional medical system. This would follow the lines created by the Chinese under Chairman Mao Tse-tung during 1953-1961. This suggestion divides the supporters of traditional medicine, however, with some arguing that cultural uniqueness should be maintained, others arguing that a unified, national, African medical culture should evolve. Both camps feel that an upgrading of traditional medicine would give value and dignity to practitioners, which has not been the case before, and both are opposed by conservative Western medical practitioners, particularly in Kenya.

Economic issue. Traditional medicine is big business. A long-distance trade in herbs, animal parts, and locally manufactured drugs flourishes; both legal and illegal networks crisscross East Africa. Zanzibar, Uganda, Rwanda, and Zaire are important sources for a vast array of herbal substances. At the same time, herbs produced for local neighborhood markets are economically important to an array of collectors, preparers, traveling traders, and local hawkers.

The economic engine that drives the traditional herbal healing trade is its relatively low cost compared to that of Western drugs, and the relative simplicity of the system. Some day a modest output of industrially produced folk medicines will undoubtedly grow up, because many entrepreneurs realize the potential of the local pharmacopoeia.

At the same time a veil of secrecy exists in the rural trade. Some of this is because of the mixture of legal and illegal trade, some because of the clandestine, family-secret nature of the preparations. Like healers, many herbal traders have learned their professions from their fathers and grandfathers. Closely guarded family secrets essentially allow traders to maintain a monopoly on a local service.

Philosophical issues. Traditional medical practitioners consider illness to be tied to non-organic, usually supernatural factors and thus do not take into account the existence of microbes, parasites, viruses, and other etiological elements in Western medical thinking. As a WHO study points out, Western medicine is based on Cartesian principles that see disease as provoked by "materially verifiable, physiopathological causes." There is a tendency now in the West away from the extreme materialistic approaches, a recognition of psychogenic ailments, and an effort to accomodate a broader, all-embracing view of the human being. But there is still a vast difference between the holistic, metaphysical traditional view and the "scientific" Western approach.

Regulation issues. Kenya and Tanzania struggle with problems of regulation. Some control is needed over both healers and the herbs they sell. Synthesis advocates recommend a licensing system to separate the legitimate healers from the charlatans and illicit hawkers, as well as a fee system to distinguish between fair trade and exploitation.

Fee controls and licensing have in fact been a part of the cooperative movements that traditional healers have attempted to form in Kenya and Tanzania. Usually, such self-policing by "guilds" or cooperatives has run into trouble. An early attempt in Tanzania to form a national cooperative of healers called UWATA disintegrated in status fights and internal squabbles.

Health team integration issue. Because traditional healers wield a great deal of influence, there are recurring pressures to bring them into health teams. The idea is to make them full members of primary health-care units, particularly where mobile units are working. Tanzania has experimented with this and held seminars in which both Western and traditional doctors participated. Kenya has such integration under review.

Issues of class and "professional" differences. In a stratified society, which Kenya is becoming, there are small sectors that do not need or use traditional medicine. Others, mainly middle-income upwardly mobile people, usually mix Western and traditional remedies. As these middle-class individuals move into higher incomes there is a tendency for them to become more "Western," in medicine as in everything else. Tanzania, on the other hand, is attempting to build a classless society, has fewer "upwardly mobile" people, and fewer class constraints against traditional medicine.

Professional sensitivities surrounding traditional medicine come in several varieties. Embarrassment and avoidance, for example, are expressed in "modern" medical circles by many African and European doctors, based largely on a generalized prejudice against "bush-doctors." The desire to be perceived as a completely modern doctor does not permit recognition of traditional medicine. Moreover, there is no question that a reliance on traditional practitioners involves some risk to the population. Many physicians are unwilling to find ways to balance such risks.

Overall, a synthesis of Western and traditional medicine raises strong arguments in both the camps. Advocates cite easy access, low costs, self-reliance, cultural appropriateness, and the shortcomings of Western medicine. Opponents point to problems of diagnosis, dosage and herbal uncertainties, sanitation, poor standards of training, an abundance of mini-specialists, issues of malpractice, and a great deal of supernatural confusion in traditional medicine.

The "Supernatural" Dimension

The greatest stumbling block, and the essence of much of the confusion in traditional medicine, lies in how African policy-makers can deal with supernatural beliefs. Admittedly, this is a conceptual jungle, steeped in historic and cultural nuances. Supernatural beliefs are basically ways of coping with fear and insecurity. Fear in this context is the twin face of illness. Unquestionably, illness causes fear, and fear causes illness. Africans have known this for centuries and have sought to incorporate ways of dealing with fear into their traditional healing systems. Any understanding of the medical-supernatural realm demands an understanding of this notion of fear.

Unfortunately, we have been badly sidetracked by the concept of "witchcraft." This is an archaic term, justly disliked by African leaders who resent its derogatory connotation of skins, beads and backwardness.

African "witchcraft" systems are essentially fear systems, roughly analogous to those of the Ku Klux Klan and the Mafia in the United States or the Mafioso in Sicily. Essentially they are closed systems of terror, perpetuated by the use of seemingly random violence or the occurrence of ill health and untimely death, carried out for clearcut reasons. On a personal level this could be for revenge, profit, exploitation or assassination. More broadly, fear systems exist for group exploitation and control, as with the Ku Klux Klan. Fear is a psychological, psychosomatic process in any society; witchcraft is the effort to use and manipulate fear, as opposed to the attempt to relieve it. Defining "witchcraft" as a fear system strips it of some of the hocus-pocus and clarifies some of the problems surrounding traditional medicine, but there are still rampant misunderstandings. It is important to distinguish beneficent practitioners from malpractitioners, the trained from the untrained, established healers from quacks and charlatans.

We may describe four categories of activity, distinguishing good from evil and the natural from the supernatural (see diagram). First, there are healers that rely on "natural" processes, with little or no claim to supernatural intervention, and are believed to do "good." Second, a camp of malpractitioners, evil-doers, also exist. These might include poison specialists, dealers in debilitating drugs, or practitioners specializing in the delivery of injurious substances.

Third, turning to the "supernatural" realms, there are people thought to have been born with special powers, who are believed able to protect one against supernatural threats. Fourth, on the negative side are those thought to be all-powerful, supernaturally and consummately evil; the terms "witch," or "wizard" are often applied. Clearly, the activities in the two lower boxes of the diagram are to be opposed, while that in the upper right corner may be helpful to the patient.

	Real	Imagined
Good	Physical Healing/ Counseling	Supernatural Protection
Evil	Physical Vengeance	Supernatural Vengeance

The Search for a Policy Synthesis

The key to Kenya's reluctant stance on traditional medicine lies in the country's strong drive to attain distinction in modern medical circles. Kenyan doctors did the first kidney transplant in black Africa (1978) and launched the first official family-planning programs in Africa (1966). The emphasis is on technology, tertiary care, specialization, and professional achievement. In the past there has been relatively little emphasis on the sectors that would be closer to traditional healing, such as primary care, prevention, family medicine, or some of the newer movements emphasizing nutrition, harmony, self-reliance, holistic medicine, and the like.

Moreover, there is continued pressure to maintain a centralized health structure. The Ministry of Health has evolved as the monolithic authority, with the provincial, district and subdistrict facilities all tightly tied to the center. Resources do flow from the center, and their "trickle-down" does not allow for traditional practitioners. In addition, Kenya has a strong private medical sector. Particularly in

Kenya's two main cities, Nairobi and Mombasa, there exists a high level of sophistication in medical services available for purchase. This sector is uninterested in any kind of synthesis with traditional medicine.

The Kenya map of the agriculturally rich areas offers another clue to the historic opposition to any synthesis of traditional and modern medicine. People in the rich central highlands, essentially comprising the Kikuyu, Embu, and Meru peoples, are ultra-modernists and rely as much as possible on modern medicine. Early missionary activity in this relatively healthy area provided both Western medicine and an ongoing criticism of traditional practices as a part of the "supernatural dark age." In other areas of Kenya traditional healers have flourished; these regions represent probably 75 percent of Kenya's population. However, it is the people from the central highlands who have been instrumental in establishing national health policy.

In recent months, however, there have been a few indications that Kenya is willing to make accomodations on the synthesis issue. The Ministry of Health is now sponsoring projects devoted to research in traditional medicine and the possibilities of its incorporation into the National Health Services. The Ministry works in collaboration with the Department of Community Health of the University of Nairobi, which is also involved in the encouragement of community participation in health programs. The African Medical and Research Foundation, based in Nairobi, is also engaged in experiments aimed at retraining traditional healers to be used as auxiliaries in health care. At another level, the Institute of African Studies at Nairobi University is much concerned with the correction of the misconceptions about traditional medicine. Another indicator is that traditional medicine has finally been mentioned in a Kenyan *Five Year Plan* (1978-1983).

Traditional Medicine in Tanzania

Tanzania's efforts to synthesize Western and traditional medicine are considerably more advanced than Kenya's. At the traditional medicine research unit in Dar es Salaam, some 2,000 herbs have been collected and analyzed. In addition, the unit has conducted seminars, launched sociological research, and carried out a number of coordinated projects with another government and university unit.

The key issue in Tanzania is the search for a way to standardize the traditional and Western systems. Debate centers on whether the Chinese system of codifying their traditional medicine might work in Tanzania. China based its approach on practices in central China, mainly Han medicine, took herbs and philosophy from other sectors, and established a textbook of traditional healing.

Tanzanians suggest there is a great deal of commonality in traditional healing on an axis from Zanzibar through the central regions to the lakes, terminating at both Kogoma and Mwanza. This is a traditional trade route, originating in the early nineteenth century as a part of the Arab slave route. Today it is the main east-west artery and a rail throughway. Zanzibar, the Tanzanians argue, with its botanical abundance, is at one end of the critical axis. Traditional healers have always gone or claimed to have gone to this herbal wonderland to obtain their special herbs and healing powders. The central pathway through Tanzania has been traversed by the enterprising Sukuma-Nyamwezi people as porters and long-distance traders since the early 1800s, bringing an admixture of knowledge about herbs and plants spread along the route and a mixture of Islamic and traditional African healing approaches. Tan-

Steps Toward a Synthesis

Remembering that Tanzania has had more contact with China's health model than any African country, by virtue of a number of missions sent to and received from China, it is interesting to speculate on what a Chinese-influenced Tanzanian synthesis might involve.

If Peking's model were followed, traditional medicine would be codified in three main sectors: (1) herbalism, (2) diagnosis and prescription, and (3) the theory and philosophy of African medicine. Thereafter a guide or textbook would be produced and a traditional medical curriculum added to the Western training. China's 20 traditional medical schools in fact teach a mixed syllabus of 75 percent traditional and 25 percent Western medicine. The students would be new college graduates, but such a program on an introductory level, for example, might be open to traditional healers who are willing to undergo paramedical training.

What are some of the problems? Remembering that it took Mao Tse-tung seven years (1953-1961) to get the traditional Chinese medicine reinstated, codified, and implanted in medical schools, the process would obviously be a part of a long-term plan for Tanzania. It is not that traditional medicine will replace or rival Western medicine, but be seen as a parallel system.

Ten Steps Tanzanians have Suggested:

1. Collect, analyze, and test for side effects the commonly-used herbs and plant substances from several parts of the country (Tanzania has already done 2,000 tests).
2. Standardize prescriptions of the herbal substances and standardize recommended dosages.
3. Select, say, 500 herbs common to most parts of Tanzania and establish specific diagnosis, usage, and cost of purchase guidelines.
4. Establish a recommended fee structure for traditional healers.
5. Establish traditional healing and paramedical procedures in seminars to village leaders.
6. Develop guidelines for the history and philosophy on the positive aspects of traditional medicine.
7. Encourage traditional counseling, health discussion, divination, group healing, and faith-healing in whatever form is locally comfortable and useful.
8. Press officials and the press be required to clearly distinguish between traditional healers and supernatural practitioners (Swahili between *mganga* and *mchawi*) both in the public mind and in the reputations of the local healers.
9. Emphasize the counseling, mental-health elements of traditional healers and draw distinctions between specialized practices.
10. Insist on referrals for cases that cannot be treated by traditional means and establish guidelines for such referral.

zanians suggest that their artery could be a core, as is the Han region in China, for a codified traditional medical system.

First aid, record keeping, simple examinations, baby weighing, birth attendance, are all within the ken of a traditional doctor. The bonus to both the patient and the overtaxed government is that a local healer, by offering basic treatment, is saving the clinicians and senior medical staff for more complicated illnesses. The argument made by Tanzanians is very practical: why should a doctor be faced with a line of 300 patients when at least half are there for minor ailments or psychosomatic, stress-related problems? A traditional healer, seen as a paramedic, would sort out many of these and save the government a great deal of money. The use of such traditional paramedics is in fact within the official policy of self-reliance that Tanzania has been promoting.

Future of the Traditional Healing

What is the future of the traditional healer? The lesson from East Africa is that traditional healers are ubiquitous, adaptive, and still badly needed. Their survivial is assured for some time because they offer culturally acceptable methods of therapy, in essence combining psychiatric counseling with diagnosis and treatment. As discussed in writings of Charles Hughes, Charles Good, Fuller Torry and others, they rely on such universal processes as these:

1. Catharsis-reflection-talking out. Healers usually allow patients a great deal of time to talk about their illnesses, to reveal the real basis of their problems, and to reflect upon them.

2. Labeling. Healers divine (diagnose) and name illnesses. The naming process allows patients to have a concept of the trouble, to have it reduced, and given meaning.

3. Personal characteristics. Traits which are cultivated by healers include exceptional sensitivity, warmth, sympathy, understanding and empathy. Understanding based on having been ill with a major disease gives a healer added power.

4. Pilgrimage. Many healers expect their patients to travel a long distance to an awesome setting for treatment, thus raising expectations and allowing the travel to become part of the therapeutic process.

5. Timing. Many healers are masters at timing their therapy. Some will keep patients camping nearby and waiting for two or three days. Others call for consultation at times they know the patient is in the best mental condition, such as mid-morning.

In short, traditional healers are successful for some of the same reasons Western psychiatrists and physicians are successful. They rely upon the universal processes of empathy, sympathy, expectation, and hope.

What other factors will affect the future of the traditional healer? In many rural societies major shifts are occurring in the role of the healer. He or she is less of a ritualist and more of a counselor and herbalist. Many props which sustained healing in the past have now been eliminated. Healers' reliance on chiefs as supporters ended in the 1960s when chieftaincy as an institution came to an end. Chiefs in many African countries were discredited as colonial "lackeys," and the healer/ritualists they supported as part of an entourage tended to lose power simutaneously. The "ordeal" (usually poisonous concoctions forced upon witchcraft suspects to prove their guilt or innocence), which had been a mainstay of the traditional legal system, was outlawed in colonial times and effectively ended by the 1950s. The role of the healer ritualist as mediator between the living and the dead has also faded, particularly in areas where the strength of ancestor propitiation is losing currency.

The widespread need for the healer, however, has not faded, and healers have the ability to shift and adapt with the times. One study of the traditional healer in urban settings noted that Dar es Salaam, the capital of Tanzania, had some 7,000 healer-herbalists in practice. Many were new arrivals from the rural areas. The Kenya government reported 6,000 healers registered with the government in the late 1970s.

Individual practitioners will no doubt continue to band together into healing cooperatives, seeking licenses from governments, fixing fees, selling advice and wares to known political and government officials. At the same time, healers will attain new skills in dispensing Western drugs. Aspirin, castor oil, and such malaria prophylactics as Daraprim and Camoquin are available from traders. Other Western drugs have become a part of the healer's kit. Fundamentally, healers will survive because traditional medicine is intricately linked to pervasive metaphysical, supernatural ideas. These ideas are integral parts of the cultural belief systems, steeped in local history and lore. In fact, because chieftaincy and other traditional institutions are crumbling, healers are among the last keepers of traditional values--values that are important because they keep the world in some kind of perspective for millions of rural people.

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A Model for Community Health Care in Rural Java

Lukas Hendrata

[This article describes a method of conveying health care to poor villages by training residents for part-time voluntary service, combined with localized health insurance covering both local medicines and the fees for a nearby health center.]

The project described in this paper began originally under the auspices of the Foundation for Christian Hospitals in Surakarta, in Central Java. An earlier effort in community development/community health was begun in 1963 in several nearby districts, and this has developed into an extensive network of related programs and a community health training center based in Surakarta (Solo).

Background Information on the Health Service

Klampok is one of the 8 villages in Purworejo-Klampok, a subdistrict of Central Java. The majority of the 29,000 people in this subdistrict earn their living as small farm laborers and traders; about 20% own land for rice farming or small coconut plantations with about 20 trees. The average per capita income is estimated to be US$25 per year. The village of Klampok, some 210 km southwest of Semarang, has a population of 5,614. For some years the health services for this area have been provided by the Emmanuel Health Center, a facility sponsored by YAKKUM (Christian Foundation for Public Health) and located in Klampok. Within the national health center system, the Emmanuel Health Center functions as a

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subcenter under the Government District Health Center and serves the entire subdistrict of Purworejo-Klampok.

Dr. Yahya Wardoyo, a recent graduate from Gajah Mada University Medical Faculty, was assigned to the Emmanuel Health Center in June 1970. The staff of the center presently consists of:

2 doctors
2 midwives
4 assistant nurses
3 auxiliary workers
3 others (clerk, helpers)

The services provided at the health center are:

--health education, including family planning motivation
--general outpatient clinic
--a mother and child health clinic
--inpatient department (7 beds) for maternity and emergency services
--mobile clinic service to the surrounding villages

After an initial grant of about US$25,000 for investment in buildings, medical instruments and a jeep, the clinic has been self-supporting. Salaries, operational and maintenance costs plus part of the field activities are covered by fees from deliveries and the outpatient clinic.

All this should be testimony to a viable program and excellent community response. But after several busy years of rendering health services to the community, certain basic questions bothered Dr. Yahya and his staff. He felt that the very important element of genuine community participation was still lacking in the program. Dr. Yahya concluded that: "The community only participates when we ask it to. This type of participation has no firm roots in the community and will last only as long as we are there to maintain it." When asked what was wrong with this approach, Dr. Yahya said that the total input from outside in the form of capital as well as expertise was too large. Moreover, the pace by which the input was channelled was too rapid. "Although we did discuss the program with the community leaders, basically it was our program. The initiative was almost totally ours," he added.

Here lies the very important distinction in understanding the concept of "community participation." In order to build a truly community-based health care program, it was not enough just to have the community participate in the health efforts of the health center. Instead, the community itself should be able to take over the initiative and basic responsibility in recognizing and handling its own health problems. The health institution should function as a stimulating and enabling body, and as a technical resource for the community. In short, what was needed was a shift from "health care for the people" to "health care by the people." It is on this concept that the Klampok program is now based.

The Klampok Model: From Participation to Responsibility

This basic philosophy of a community-based health care effort was translated into the following strategy:

1. Know the community and let the community know you. One fact often overlooked is that the health center staff are strangers to the community. To overcome this gap, one staff member from the health center should informally be assigned to the village to familiarize himself with the community and to give the community the opportunity of knowing him and his mission before any program is introduced.
2. Work out programs in which the concept of community participation and responsibility can take a real, concrete and personal form.
3. Discover and understand the priority needs, constraints, and potentials within the community.
4. Work in small units. Expand the program through multiplication of these small, independent units rather than by creating a large superstructure. Enough flexibility should be given to these units to enable them to adapt and modify themselves to particular local situations.

The health workers discussed this program strategy extensively with the local community. As needs were articulated, and as specific activities were designed to meet them, the implementation of this strategy seemed to indicate two very key elements:

--the village health cadre;
--the village health insurance scheme.

The village health cadre. The village health cadres are the comprehensive grass-roots health agents within the community. They are voluntary workers from the community, selected by their community, and trained by the health center staff. The single and yet very comprehensive criterion used in the selection is whether or not a person is "right" to be entrusted with this community role. There are no specific restrictions based on level of education, sex, age or occupation. Most of the cadres are teachers, but there are also small shopkeepers, farmers, local government employees and traditional midwives.

The training given by the health center staff is very practical, problem-solving and action-oriented in nature. The emphasis is put on understanding basic health measures, nutrition education, under-five care, family planning and environmental sanitation. The boundaries of problem solving and action are limited to the actual village situation, avoiding unnecessary general and academic discussion. During their training, the cadres are given various practical assignments to equip them with the necessary skills for identifying and solving health problems. This includes organizing people in the neighborhood to clean their homes and yards and to install additional windows in their homes; to keep the weight charts of the under-five children; to find and report patients who have a cough for more than 2 weeks, and so on. They are also trained in the basic knowledge of diseases prevalent in the area. Priority is given to making them able to identify serious cases, such as malnutrition, dehydration, bronchopneumonia and obstructed labor, and to refer these cases to the health center. In addition to these cognitive skills, they are also trained in the treatment of minor ailments, emergency first aid, and minor diagnostic procedures such as rectal swab, sputum collection and blood smear preparation.

The training course is like an in-service training program. A two hour lecture and discussion is given once a week for a total of 16 weeks. At the end of this period, an additional 8-hour course in 4 weekly sessions is given to those who express an interest in becoming an instructor for the next course. In each consecutive session or course, the role of the health center staff decreases. The health center staff continues to provide general supervision and technical advice, but the main responsibility of conducting the training lies in the hands of the cadres themselves.

The formal instruction, however, plays a less important role than training which takes place in the day-to-day practical application of their newly acquired knowledge. Dr. Yahya maintains personal contact with the cadres during this difficult transitional time so that he can answer any question they might have and give encouragement. He starts his daily schedule with "cadre consultation hour" from 07.00-08.00 in the morning. Any cadre may consult with him during this time on any matter of concern to the cadre. This continued personal contact and follow-up is crucial to the effectiveness of the system. The skill of the cadres is strengthened, and person-to-person communication gives the program a deeper human dimension, a factor so often lost in bureaucratic programs and procedures.

There are now 84 cadres in the project, representing the first, second and third generations of cadres trained during the last 2 years. Once they finish their training, the various generations of cadres catalyze the community into community participation.

Part of the cadre's responsibility is to treat minor ailments and to give first aid in emergency cases. Each cadre has a small stock of medicine (12 different types) in his home. The people of the community are first encouraged to visit the cadre when they get sick, but they are free to choose either the service of the cadre or that of the health center. In Klampok, both alternatives are covered by the village health insurance scheme (see below). So the actual cost of health care is the same whether the patient chooses the cadre or the health center, except for the extra cost and trouble of transportation to and from the health center. When a disease is one that could well be treated by the cadre, the health center doctor encourages the patient to use the cadre's service. The doctor gives exactly the same standard treatment as would be given by the cadre if he were the one to treat the case. This policy was built in to ensure the community's natural growth of confidence in the cadres. It also gives the cadres time to build up their skill and self-confidence in practicing what they have learned during their training without any pressure.

Within some months, the average cadre is accepted and trusted by the community. Very soon the community realizes that, for minor ailments, it is more convenient to use the services of the cadre instead of the health center which, after all, gives exactly the same standard treatment. The average patient load of a cadre is 5 to 15 patients monthly; 1 to 2 of them need to be referred to the health center. Moreover, the cadre maintains a simple patient-recording system by which the doctor gives his guidance and supervision.

Compared with traditional clinic outreach programs, the cadre system has several very fundamental advantages which make its workers the more effective health agents in the community.

1. The cadres are "insiders." They are from within the community and selected by their neighbors; the community understands and accepts them more readily. Their contact with the community is more permanent in nature, compared with the sporadic "health campaigns" from the health center.
2. Their training is specifically geared to local situations and emphasizes problem-solving skills. While standard health education activity often stops at the point where health lessons are memorized, the cadres put their knowledge and skill to work through supervised problem-solving activities as part of the training.
3. The cadres are voluntary workers. This puts them in a position of respect in the community, a position with higher "moral authority" than that of a paid health worker.
4. They work in small units. In Klampok, there is one cadre for every 15 households. This small unit is

important to make them manageable, since the cadres are volunteers and part-time workers; most continue their regular occupations as well. In addition, the small unit provides the flexibility needed for adaptation to each local situation.

The Village Health Insurance Scheme

One of the most important obstacles in providing health care in Indonesia relates to economic factors. The sections of the community with the greatest health care needs are those with the lowest economic capacity. The health cadre system has been successful in reducing costs.

Based on the same principle of community responsibility, the village health insurance scheme tries to mobilize the existing economic potentials of the community in order to meet the cost of its members' health care. The first and most important step in implementing this scheme is social preparation. This is managed through a continuing series of discussions on the basic principles as well as the health and administrative aspects of the scheme which are attended by the community members, the local community leaders and the health personnel.

The scheme was implemented through the existing village administrative structure, the RT or neighborhood system. (RT = block. A city is divided into districts and the districts into hamlets; each hamlet is subdivided into blocks, which have approximately 50-100 families.) To be a member of the insurance scheme, each household has to pay a monthly contribution of Rp 50 (US$0.12). This represents about 1% of their monthly income. As members of the scheme, they are entitled to health services which include curative services given by the cadres and by the health center, as well as the total family care, such as regular baby weighing, nutrition and health education services.

The contribution is collected and administered by the RT chief. The fund is used to cover the regular health expenses of the community such as the health center fee and the cost of medicine used by the cadres. Should there be any shortage of funds to pay the health center fee for a particular month, the RT can get one or two months' credit from the health center. Most of the time, however, the fund is sufficient to pay the expenses. Sometimes, there is even a positive balance in the RT's fund. In that case, the community decides how the balance should be used, e.g., in such health-related activities as building community latrines or improving the sewage system, or used as "back-up" funds should there be a health need which cannot be covered by the monthly contribution.

The village health insurance scheme opens up economic possibilities for all members of the community to pay their health expenses. An even greater value of the scheme may be that it creates and maintains a community forum in which health can be discussed as a relevant community issue. Since health is so closely related to other aspects of life, the forum will also be dealing with general development issues and a broad range of community activities. These activities, which aim at improving the quality of life in general, can have a greater and more lasting impact on the level of health than any direct health measures.

In Klampok, the village health insurance scheme and the village health cadre system are mutually supportive. The insurance scheme provides the cadres with a working structure. Medicine used by the cadres is paid for from the insurance fund. At the same time, the cadres are the promoters and organizers of the scheme. By treating patients with minor ailments, they screen the patient flow to the health center and reduce the total cost of treatment to a level within the community's reach.

Discussion

The Klampok model has as its primary emphasis the establishment of new perspectives in the relationship between the health institution and the community. Rather than as a "distributor" of health services to the community, the project staff sees its main role as a stimulating and enabling one, so that the community will be able to accept the responsibility of recognizing and handling its own health problems, and feels that this should be the goal of any community health program. In Klampok, the village health cadre system and the village health insurance scheme are two mechanisms which have proved successful in meeting this goal.

The model is remarkable in its local relevance and simplicity. As Schumacher aptly put it: "Any third rate engineer--or doctor, for that matter--can increase complexity; but it takes a certain flair of real insight to make the thing simple again." (E. F. Schumacher, Small is Beautiful.) And this insight only comes to people who allow themselves to be submerged in the real world of the community, and to accept its limitations. Technically, there should be no difficulty for an average doctor and other health personnel in implementing a similar model for their community. Financially as well, simplicity marks the entire program. The starting capital is relatively very small, and it has been shown once again that sophisticated and therefore expensive classrooms are superfluous. The classroom is the home, the community, and the functioning health center with a simple room. There is almost no extra cost involved other than the regular running cost of a health center, which can be covered either by the patient fees or government subsidy.

But is this program replicable? Our experience in Indonesia indicates that the Klampok model is indeed replicable. The health cadre system has now spontaneously spread to several surrounding villages. The health insurance scheme has also proved to be viable in other localities.

True, there is the question of leadership, and leadership with the quality of compassion. In most countries today, the method of selecting and training health personnel has a strong tendency towards "professionalism" and "elitism" that contributes to separating the health personnel from the community. Further, the concept of true community participation in articulating its needs, planning, making decisions and directing its own health concerns, is still foreign to most health care planners. It is understandable, therefore, that this type of leadership is not easy to find. Clearly, also, a reorientation and remotivation of both health personnel and community leaders is needed. Health is basically "a matter of the heart." Only where medicine is the servant of the community rather than its master is there some hope for community health.

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Editorial Note: Recent information from Indonesia indicates that in the four years since this article was written both the training and use of volunteer health workers and the formation of localized health insurance groups have continued to spread through central Java and elsewhere.

Traditional Midwives: Controversial Community Health Workers

Mayling Simpson-Hebert, Phyllis T. Piotrow,
Linda J. Christie and Janelle Streich

[Conflict and accommodation between modern and traditional values--in this case between modern and traditional medical practice--is a continuing process. While scientific evidence and lower death rates are usually--although not always--on the side of modern medicine, customs, cost and client convenience are frequently on the other side.]

The practice of midwifery--helping women to give birth--undoubtedly existed long before the advent of writing. Throughout the Greek and Roman periods in Europe and during the great Islamic Empire of Middle Eastern history, midwives apparently practiced alongside university-trained physicians without conflict.

The development of the European guild system in the 13th century, however, and especially the establishment of barbers-surgeons guilds, meant that midwives were increasingly excluded from training and licensing as legitimate health practitioners. Only members of the surgeons' guilds were permitted to use instruments; so when forceps, for example, became available in the 18th century, female midwives were neither allowed nor trained to use them. Also at this time, men began to enter the field of midwifery. Yet, because obstetrics was not recognized as a legitimate medical specialty until the middle of the 19th century, both obstetricians and other practitioners

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tended to aggrandize their own role by criticizing the allegedly dangerous and unhygienic practices of the traditional midwives.

The developed countries faced difficulties in adapting midwifery to scientific medicine and, indeed, have had a mixed record. Today the developing countries in Asia, the Middle East, Africa, and Latin America face some of the same problems and controversies in working with their traditional midwives to help improve national health services. A dual system of medicine exists now in many developing countries--a modern/ scientific one and a traditional one. The modern health sector consists mainly of university-educated physicians, practicing in urban hospitals and research centers, sometimes combining a government post and private practice, and often putting in a 12-hour day working on curative medicine and administration. The traditional health sector, both urban and rural, consists of a great variety of indigenous practitioners, including traditional midwives, who live close to their clients, dispense herbs, potions, massage, and other familiar remedies on request, and take time to provide conventional wisdom and personal services for people who speak the same language, both literally and figuratively, and often come from the same background. For most villagers and many city dwellers in developing countries, going to a traditional practitioner is more comfortable, more convenient, and usually less expensive than going to a physician or hospital. Unless the would-be patients are absolutely sure that only a physician and modern technology can take care of their problem, they are likely to try the traditional practitioner first--in much the same way that an American with a cough will buy a patent medicine from the drugstore before making a doctor's appointment. In other words, the so-called modern medical system has not replaced the traditional one; it has only created another option that some people will use sometimes for some conditions.

Modern medicine, although it exists to some extent in virtually every country, is an option that is often not truly available to most people. The ratio of population to doctors and nurses in most developing countries is very high, at least several thousand per health professional. Doctors and nurses tend to be concentrated in urban areas, where the ratio is about one doctor per 2,000-3,000 people, while in rural areas, where 60 to 80 percent of the population lives, the ratio is about one doctor per 40,000-50,000 people. As populations grow and doctors emigrate, the ratios become even worse in some countries. Traditional midwives, on the other hand, practice in almost every village in many countries and so are certainly more accessible to most women than either physicians or hospitals.

Ideally, scientifically trained practitioners should work cooperatively with a broad range of indigenous practitioners to meet the compelling health needs. The indigenous practitioners could learn how to use many modern drugs and techniques safely. In turn, scientifically trained practitioners could learn both how to apply culturally accepted indigenous practices or adapt them in such a way as to make them safer, and how to introduce modern practices in such a way as to make them culturally more acceptable. In practice, however, hostility, or at the very least poor communications between the educated health professionals--physicians, nurses, and formally trained midwives--and traditional midwives is often cited as a major problem in such programs.

Nevertheless, it is widely recognized that the role of traditional midwives--as well as that of other traditional practitioners--is not likely to be eliminated soon. Legal or illegal, trained or untrained, these midwives continue to deliver 60-80 percent of babies born in the developing world and to provide a variety of health services to many women. Therefore a number of countries provide for the registration or licensing of traditional midwives. Further, some governments like Indonesia, Malaysia, the Philippines and Thailand, international agencies such as the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), and private institutions have undertaken programs to train and improve the skills of traditional birth attendants. China has followed the most comprehensive policy of enlisting practitioners of traditional medicine in village communes in a cooperative effort with modern medicine. In rural areas, community women have become midwives--"barefoot doctors." These village people participate in three to six months of practical training and perform their health duties part-time, delivering babies at home, providing a broad range of maternal and child health (MCH) and preventive services, and sharing in the other work and resources of the commune.

In 1972, the United States Agency for International Development (USAID), as well as other donor government agencies, began to work with the International Confederation of Midwives (ICM) in cooperation with the International Federation of Gynecologists and Obstetricians (FIGO) to include family planning in services provided by midwives of all categories and especially by traditional midwives. Some 20 meetings have been held.

During recent years several factors have helped to focus attention on the role and potential of traditional midwives. These factors include concerns over (1) high levels of infant and maternal mortality in developing countries, which have prompted a number of programs using community workers in MCH; (2) high rates of population growth, which have led private agencies, governments, and international agencies to try to use indigenous community leaders to encourage family planning; and (3) the urgent need for better primary health care facilities to serve large rural populations, which has been expressed in resolutions approved by the International Conference on Primary Health Care, sponsored by WHO in Alma Ata, USSR, in 1978. Over the last decade, attention in the field of family planning has shifted from medically oriented programs, based in clinics or hospital centers, to community-based projects where village women and leaders distribute contraceptives directly to local users. While hospitals or clinics still perform sterilizations, IUD insertions, and legal abortions, many relatively untrained people are now playing a major role in family planning programs in Asia and Latin America.

It has still not been easy either to incorporate traditional midwives into a more formal modern health care system or to utilize them effectively in family planning programs. Whether their proposed role is as motivators (referring clients or potential family planning acceptors to health care facilities), as providers (performing various procedures themselves), or as suppliers (dispensing medicines or some contraceptives), traditional midwives do not necessarily perform the way government or other health officials think they should. This is often not their fault but rather the result of programs that have not been designed to take sufficient account of how the traditional midwives actually function in a specific community, and what they already do for their clients. These affect what they may be willing or able to accomplish in any new program.

Characteristics of Traditional Midwives

In most developing countries, traditional midwives are nonliterate, postmenopausal village women who have been married and borne several children. Yet in some areas--Bali, Ghana, Nigeria, and Bolivia, for example--many birth attendants are male. Midwives are usually older, because in traditional societies older women are more respected, they are not so restricted to the home either by modesty or by the responsibilities of child care, and they have more experience with deliveries. Yet in Mexico young women are also becoming accepted as *parteras*, and in Sudan young traditional midwives are selected by the government for training to become "village midwives." Younger traditional midwives tend to be more literate, more active, and more accepting of family planning.

In most cases, traditional midwives enter their profession by apprenticeship to an older midwife, usually a relative or close friend. In Thailand most midwives enter the profession simply by proclaiming themselves to be *moh tam yae*, while in other countries traditional midwives feel themselves called by supernatural forces to take up midwifery as a religious duty or a service to the community. Also, midwives may be informally selected or designated by their friends and neighbors because they have special skills.

Some traditional midwives are active in serving the whole community, whereas others help only their own family and neighbors. This is an important distinction, and may help to explain why some are more effective recruiters of family planning acceptors than others. Often a traditional midwife inherits her clientele from the older midwife to whom she was apprenticed. Thus her practice may be restricted to a set of extended families, so that actively recruiting others would not be appropriate. The practice of a rural midwife is also limited to the geographic area she can reach by foot, animal, or sometimes public transportation. In most rural areas midwifery is a part-time job, and traditional midwives work at agriculture or other local activities most of the time.

It is necessary for modern health planners to take into account the personal characteristics of traditional midwives (sex, age, extent of literacy, level of activity), their status, traditional practices, and degree of influence over their clients in efforts to collaborate with them to improve maternal and child health and family planning accessibility. All of these characteristics and factors may vary, and in some cases may operate against effective collaboration unless the special needs of traditional midwives are considered.

Work of Traditional Midwives

The work of traditional midwives is as diverse as their backgrounds. In many societies traditional midwives do much more than their name suggests. Some would be better described as "traditional healers" who care for women, especially during their reproductive years and childbirth. They not only deliver babies but also assist women during prenatal and postnatal periods, give advice on child care, infertility, and contraception, perform abortions, and play important ritual and religious roles. A number of these practices may be personal skills or techniques acquired from experience and guarded as professional secrets, but most reflect the cultural patterns of the area.

Prenatal care. The extent of prenatal care ranges from almost nothing in much of India, Pakistan, and Bangladesh to close and continuous personal contact in parts of Southeast Asia and Latin America. In these cultures, a pregnant woman may visit the traditional midwife or be visited by her early in pregnancy, at which time the traditional midwife might determine her delivery date, perform the first prenatal massage, or advise her on diet, activity levels, and sexual relations with her husband. Dietary advice in Latin America, the Middle East, and South Asia is based on a "hot and cold" humoral theory of health and illness (not related to temperature), which varies greatly from one locale to another.

In many parts of Asia, the Middle East, and Latin America, massage is an indispensable part of prenatal care. During pregnancy, the traditional midwife, who often has a highly developed sense of touch, may use massage to relax muscles, relieve discomfort, and estimate the progress of pregnancy. As delivery approaches, massage is used to position the fetus or to loosen the placenta in preparation for delivery. In the Yucatan, Mexico, for example, traditional midwives perform external version to avoid breech delivery any number of times from the eighth month until the head is engaged. This is uncomfortable for the woman but probably safer and certainly more convenient than traveling to a major city for a cesarian section.

Labor and delivery. In most traditional societies childbirth is a social event rather than a medical one. Female relatives and neighbors are present. While the role of the traditional midwife varies--in South Asia she may be little more than a servant cleaning up--often she is the central figure, playing an active role during labor, delivering both baby and placenta, and directing others present in their respective roles. During labor the traditional midwife may massage the woman and administer herbal beverages, sometimes containing oxytocic ingredients, in order to accelerate labor. At delivery many midwives help to extract the baby and the placenta.

One of the most important duties of the traditional midwife is cutting and dressing the umbilical cord. As a rule, the cord is not cut until the placenta has been expelled. While a trained midwife almost always carries a kit containing supplies, including scissors, untrained midwives often use equipment found in the household. In India the tool used to cut the cord may depend on the occupation of the family--a knife for leatherworkers, a trowel or sickle for farmers, or scissors for tailors. The traditional midwife dresses the cord with ghee, dung, ashes, or herbal preparations, according to local custom. Often the cord is tied as well as cut and dressed. Sometimes it is cauterized and hot wax is applied, as in Mexico and Guatemala.

Postnatal duties. The work of the traditional midwife may continue after delivery, when she may help to care for mother and child. The midwife usually bathes and clothes the infant according to the practices of the region. It is common, especially in Asia, for traditional midwives to provide help in house cleaning, washing, and cooking after delivery to give the new mother an opportunity for rest and time with her baby. This is an important difference between traditional midwives and educated or government-salaried midwives.

Traditional midwives also perform medical functions, such as providing herbs and medicines to stop heavy postpartum bleeding or to stimulate the milk supply. They help women start breast-feeding. Repair of perineal tears may also be part of the midwives' task. Many traditional midwives take an active role in hastening the recovery of the mother, using a wide range of traditional treatments such as massage, baths, binding, and herbal medications. These postpartum duties bring the traditional midwife into close and frequent contact with village women and provide many occasions to discuss questions of health, childbearing and fertility.

Rituals. Childbirth in all cultures is surrounded by a diverse array of rituals. Traditional midwives play an important role in the ritual and religious aspects of childbirth, all the way from using occult means of predicting the sex of the baby to participating in coming-of-age ceremonies. These rituals vary widely, and they can be used to gauge the traditional midwife's influence in her community and perhaps also her potential role in health care programs.

Disposing of the placenta is almost always the responsibility of the traditional midwife and frequently assumes ritual significance. In Cameroun, for example, one reason that women continue to deliver with traditional midwives in spite of sufficient numbers of government maternity units is to guarantee appropriate disposal of the placenta. In Malaysia the child and placenta are considered to be siblings. Since it is thought that the two are reunited at death, the *kampong bidan* carefully washes the placenta, cord, and membrane and wraps them in a white cloth to be buried. In other societies, such as in Northern India, where the afterbirth is thought to be polluting, only a low-caste traditional midwife will handle it. Midwives bless new infants and try to protect them from evil forces. In much of the Muslim Middle East, soon after the birth of an infant a traditional midwife whispers sayings from the Koran in the baby's ears.

Fertility-related services. Traditional midwives are often asked for advice both on how to cure infertility and how to prevent unwanted pregnancy. Treatment of infertility is important since a barren woman is often ridiculed, made to feel useless, and divorced. Traditional midwives use a great variety of techniques to try to deal with this problem--which often eludes even advanced medical science--including massage to turn a retroverted uterus, warm baths, herbal medicines, intercourse on prescribed days, vaginal suppositories of unknown efficacy, and secret rituals, sometimes involving pieces of placenta from a successful delivery.

To control fertility and especially to space births, the most common traditional methods recommended by midwives are abstinence, withdrawal, and abortion. Breastfeeding, of course, also limits fertility and is usually encouraged by all traditional practitioners. Abstinence is often reinforced by religious teachings or taboos and by such specific guidelines as postponing sexual intercourse while the woman is lactating or until the child reaches a certain age. In Cameroun, for instance, the traditional midwife reportedly advises abstinence until the child cuts premolar teeth, can walk, reach one ear with the opposite hand over the head, or address members of the household by name.

Regardless of the legal status of abortion many traditional midwives perform them, and sometimes even derive a major part of their income from abortion. In Asia, for example, where most data has been gathered, one Philippine study shows that about one-third of abortions in a group of rural women were performed by the traditional midwives; an Indonesian study reported that 12 percent of traditional midwives admitted to performing abortion; a study of abortion providers in Lahore, Pakistan, indicated that traditional midwives performed about 15 percent of abortions in the study group, and a study in Thailand revealed about 12 percent. Two studies of abortion complications in Bangladesh showed that more than half of the complications and deaths occurred after abortions performed by traditional midwives.

Many traditional methods of child spacing and especially of abortion can be dangerous as well as ineffective. The high frequency with which they are used indicates the demand for fertility control services. The fact that traditional midwives are so often involved indicates their potential to help satisfy that demand. As knowledge of and demand for family planning increases, it may be only a matter of time before traditional midwives voluntarily incorporate family planning services into their regular practice, whether or not they are formally employed by national programs to do so. Giving traditional midwives easy access to ample supplies of contraceptives which they can sell will help to accelerate this process of change.

Status of Traditional Midwives

While traditional midwives do not have high status among hospital personnel, medical practitioners, and educated urbanites, they are almost always respected in their own communities as a source of information and advice about baby care, sexual behavior, fertility control, health, and related matters. In Indonesia, Malaysia, the Philippines, Thailand, and much of the Middle East, Africa, and Latin America, traditional midwives are influential among the women they counsel and help. In India, Pakistan, and Bangladesh, their status is variable but generally much lower, yet they are considered influential in sex-related matters and childbirth. Dr. John Bryant, Deputy Assistant Secretary of International Health for the U.S. Department of Health, Education, and Welfare, describes the *moh tam yae* in Thailand as follows:

> *There could be no greater mistake than to consider her a dirty-handed granny with a slovenly and superstitious approach to a procedure that should be neat and sterile. The woman is a priestess. She not only has important technical and domestic skills; she also ensures the cultural and religious integrity of the event . . .*

In some societies the relationship between a child and the traditional midwife continues for months or even years after birth. For example, in Indonesia the *dukun* officiates in a series of ceremonies that occur up through seven months of age, and in Thailand children delivered by a midwife may give her gifts at an annual festival. In Morocco the midwife is invited to a celebration when a child she has delivered can recite by memory from the Koran, and in Egypt and Iran the child's affection for the midwife who delivered him or her often lasts into adulthood. In some countries the traditional midwife may come to be regarded like a grandmother or a godmother.

Only in the Indian subcontinent do most midwives have low status. This is related to cultural concepts of clean and unclean work. In India, Pakistan, and Bangladesh menstrual blood, the placenta, and blood of childbirth are considered ritually polluting and symbolically dangerous substances. Only women of the lowest social classes and castes are willing to come into contact with these materials. In North India the Sweeper and Untouchable castes from which traditional midwives come work in leather and other products of dead animals, bury the dead, clean the street, empty bucket latrines, and perform other "unclean" tasks.

For all her services, the traditional midwife accepts payment in kind, cash, or none at all, according to local custom or the financial means of the family. Much of her recompense, especially in rural areas, comes in the form of high status and prestige in her community, gifts, favor, or support over a long period of time. In urban areas or where a traditional midwife specializes in a service such as performing abortions, fees are likely to be higher and paid in cash. In their 1975 overview of traditional midwives' programs in half a dozen countries, Everett Rogers and Douglas Solomon estimated that a traditional birth attendant averages about three deliveries per month and receives about $1 to $3 (US) per delivery. She is usually paid more for delivering a first born or a son. As a private practitioner, she is also paid by her clients for herbal medicines, potions, massage, and other services or supplies she may provide in addition to attending births.

Working with Modern Medicine

Conflict and accommodation between modern values and traditional ones--in this case between modern medical practice and traditional practice--is a continuing process. The medical profession tends to consider traditional midwives unhygienic, unscientific, and superstitious old women who jeopardize the lives of mother and child. It is said that they wear dirty clothes, do not wash their hands, conduct unnecessary vaginal examinations, pound on or push roughly on the abdomen, fail to recognize breech or other abnormal presentations, pull on the umbilical cord to extract the placenta, delay too long in referring or transporting women with serious complications of labor to medical facilities, and, above all, use dirty instruments and dressing on the umbilical cord, contributing to infection and tetanus in the infant, which is often fatal.

Many traditional midwives are just as critical of modern practitioners. Although they do not write articles in scientific journals, traditional midwives have complained to anthropologists and others that

What Educated Health Services Personnel Say About Traditional Midwives

Doctors Say

- They are ingrained with bad habits you can't change, like smearing dirty substances on the cut cord, squeezing the laboring abdomen, and spitting in the baby's eyes.
- Their standards are too low. Some kill their clients. Many complications of their dangerous practices are seen in the hospitals. They refer their patients late, and only when they are in extremis.
- They work by superstitions and magical and religious thinking. Hence, they cannot distinguish good practice from bad, and they could not grow in skills on the job.
- The homes are filthy and unhygienic. If we get women to deliver in maternities there will be less risk of infection, and more chance for the mother to rest, as well as special care for the baby if it is needed.

Administrators Say

- Pregnancy and childbirth are the most important events for contact with the population in building up primary health care/maternal-child health services. We must put them at the center of our program. We must control the quality of services by doing these through our health facilities.
- They can't keep records, being illiterate and unsystematic.
- Most of prenatal and postnatal care is educational; how can one expect ignorant, illiterate women to adequately educate the population?
- If we start to train them, they'll organize, become an interest group, demand payment.
- Anyway they are old, are dying out, are not being replaced by young TBAs. They will just naturally fade away as we train bona fide midwives. Hence it is not worth investing our limited resources in upgrading or working with them.

Licensed Midwives Say

- They are too popular with our clientele in the rural and some urban areas, appealing as they do to the ignorant, superstitious, and harmful attitudes of women, whereas we appeal to and try to develop the rational, scientific, hygienic attitudes of women.
- The TBA is my competitor for paid, outside-the-maternity home deliveries, and I must draw her clients away from her to my better care; in retaliation, of course, she spreads lies and rumors about how uncaring, commercial, ignorant of ritual, and dangerous my services are compared to hers.
- We have to supervise the TBAs, and I don't have time for it.

Source: Thorne

physicians and hospital-based obstetric services use dangerous chemicals to induce labor, place women in awkward and immodest positions, prohibit family and friends from coming to provide psychological support, use forceps carelessly, perform too many cesarean sections, and expose the women to all kinds of unnecessary procedures and sicknesses.

Everywhere modern practitioners try to assume control over traditional practitioners, to supervise their work, and to compete with them for clients among those able to pay. Since the educated public and private health doctors see the cases where the traditional midwives have failed, they sometimes try to prohibit the midwives, who have little political power, from practicing. On the other hand, the older, experienced traditional practitioners, including midwives, resent the claim of younger, school-educated health personnel to know more than they do, and they often try to avoid the latter unless a patient is in danger. The hierarchical structure of the modern health professions and the efforts of some doctors, nurses, various categories of trained midwives and auxiliaries to define very sharply their own roles and status make it especially difficult for them to work with an entirely different, traditional medical network that finds its legitimacy in valued customs and community acceptance. Except for China, few governments have tried to integrate the two systems on anything like an equal basis.

What Traditional Midwives Say About Modern Health Services

- The health services give awful care. They make women wait a long time. They are rude, insolent, and give strange treatments. They hurt and embarrass women. They will insert strange things in a woman's body even without her knowing it; then the woman will have pain or bleed. They give pills that make women dizzy, and sometimes sterile, or ruin the pleasure with their husbands.
- The health service personnel are shameless the way they expose a woman. They are irreligious; they do not say prayers or perform rituals to ward off evil fortune. Neither I nor my clients understand their way of speaking.
- The health services midwife treats me poorly if we meet. She says bad things about me. I give good service in my community. I do many things that are important that the midwife doesn't even know about. She might try to stop me if she did know about them.
- When a woman needs care, often the health services are not available, but I am always available to help my women. Often they do not have the supplies a woman needs. They never spend with a woman the time she needs.
- The midwife is trying to steal my clients.
- If they want me to promote contraception, what will happen to the deliveries I depend on?
- It is dangerous to have dealings with outsiders.

Source: Thorne

It is not always clear which practices of traditional midwives are dangerous. Drs. Cicely Williams and Derrick Jelliffe proposed in 1972 that traditional practices should be classified as beneficial, harmless, harmful, or uncertain (see figure below showing this for two areas). From these examples it is clear not only that much of what the traditional midwives do is beneficial but also that obstetrical practices change, and what is recommended at one time may be criticized at another. Although cleanliness and aseptic technique are always beneficial, there is very little scientific evidence that sitting up or walking about is harmful during labor, that massage is necessarily dangerous, that freshly cut bamboo or a thread cannot be safely used to cut or tie the umbilical cord, or that hospital delivery is always safer than home delivery. Some traditional practices, such as cauterizing the cut stump of the umbilicus with a candle--as is traditionally done in Mexico and Guatemala --may be just as safe as using sterilized scissors. It should also be remembered that many causes of sickness and death are environmental, beyond the control of either doctors or midwives.

Beneficial, Harmless, and Harmful Practices of Traditional Midwives, Two Examples

Guatemala			Rural Punjab		
Beneficial	**Harmless**	**Harmful**	**Beneficial**	**Harmless**	**Harmful**
• Respond and arrive promptly in times of need. • Create atmosphere of trust and confidence. • Recognize mother and baby's need to be together. • Recognize need for other family members to be present at childbirth. • Attend to mother and family for long period after birth. • Remain with women during labor; do not force women to bear down too early. • Allow women to move, sit, and walk during first stage of labor, and to assume squatting position for delivery. • Support women psychologically and emotionally; maintain close personal relationship with her.	• Require umbilical cord to be a certain length. • Require proper disposal of the placenta. • Administer ritual baths to mother and infant three days postpartum. • Share and respect woman's modesty in childbearing matters.	• Fail to use aseptic procedures and materials in delivery, care of newborn. • Perform strong abdominal massages. • Tie sash around woman's abdomen to hasten delayed delivery. • Hold woman upside down by her feet to correct abnormal fetal presentation. • Restrict intake of "cold foods" (fish, pork, fruits) in postpartum period. • Advise giving infant sweetened water until mother's milk "comes down." • Refrain from referring patients to hospital in case of emergency.	• Give care and attention to the woman's physical and mental state of health from the time of confirmation of pregnancy until 40 days after childbirth. (This includes building up her physical strength, self-confidence, and will power.) • Advise avoiding sexual intercourse in the third trimester of pregnancy. • Wash mother's dirty clothes and dispose of bandages after the childbirth. • Encourage prolonged breast-feeding. • Provide services in an atmosphere of cordiality, mutual trust, and interdependence. (In contrast to the strange, impersonal atmosphere of the hospital.)	• Wear amulets and charms to ward off evil spirits. • Advise avoidance of contacts with strangers during the period of delivery and seclusion. • Advise women on disposal of placenta in a culturally prescribed manner to avoid harm to the newborn through black magic. • Advise women regarding performance of inexpensive ritual ceremonies, such as purification bath. • Treat mother's minor illnesses with certain harmless indigenous medicines. • Treat child's minor illnesses with home remedies.	• Advise undereating in the third trimester of pregnancy. • Advise avoidance of consuming certain locally available nutritious foods. • Vigorously massage the woman's abdomen during the second and third months of pregnancy. • Lack of asepsis in procedures adopted for delivery. • Advise excessive intake of "desi ghee" to lubricate the birth canal. • Refer seriously sick children to indigenous medicine practitioners.

Source: Hurtado (208)

Source: Kakar (239)

Family planning. Can traditional midwives play a role in family planning programs? In practice their role varies from education and referral--most commonly--to supplying or selling the pill and other contraceptives to village users, as has been done in Malaysia, Mexico and several other countries. Giving traditional midwives ample supplies of pills to distribute sometimes arouses medical opposition but suits traditional roles, is safer than many traditional fertility control methods, and has been effective in several countries. Traditional midwives proved unsuited to insert IUDs in the early South Asian programs; they should be discouraged from performing surgical procedures. It makes a difference, however, which traditional midwives are selected to participate in a program. Some serve a larger clientele than others. Generally younger women are sympathetic toward family planning, but older women have more influence in the community. Identifying the most active and influential women--whether traditional midwives or not--has been an effective way to spread family planning in countries as different as Bangladesh, Egypt and Mexico.

Evaluation of family planning programs for traditional midwives has been minimal, although such projects have more often been evaluated than those involving childbirth and MCH practices. Experience suggests that programs like those in Malaysia and Mexico, where traditional midwives have been allowed to distribute contraceptives directly, are more effective than programs where traditional midwives are required to refer their clients to a health center for all family planning services. At a moderate cost, calculated in the Philippines as less than $1 (U.S.) per new acceptor, traditional midwives can provide access to modern means of family planning as a substitute for the traditional methods which they provided in the past.

The key question for health and family planning programs is to what extent better training of traditional midwives and better communications with modern health services can improve their performance and reduce infant and maternal mortality. Tetanus, for instance, can be somewhat reduced by use of a sterile knife, razor, or thread to cut or tie the cord, and can be virtually eliminated by immunization programs. But even immunization campaigns need the support of traditional practitioners. Other infections can be reduced by greater cleanliness, but it is not easy to maintain a sterile environment under dusty conditions where both water and fuel for boiling it may be scarce. Traditional midwives can be trained to recognize complications early and to bring difficult cases to clinics or hospitals, but, if trained health personnel are not there, the outcome could be worse. Traditional midwives can also be taught to recommend and provide means of family planning, although they may be less than enthusiastic if they have to refer women to someone else for supplies.

Brigitte Jordan, an anthropologist at Michigan State University, has suggested that two kinds of research are needed: (1) biomedical studies to determine which traditional practices are beneficial and which harmful, and (2) anthropological studies to determine how modern medicine can best adjust to the customs and expectations of traditional societies. Closer collaboration between traditional and modern practitioners could improve MCH care and family planning acceptance in many developing countries.

In many places such cooperative relationships already exist to the mutual benefit of doctors and traditional midwives. In Taiwan traditional midwives often assist young, recently graduated obstetricians in setting up new practices, as well as forming professional partnerships with them at "birth stations." In one such case an older nonliterate traditional midwife joined with two other midwives and a young male obstetrician to operate a midwifery clinic (or birth station) in her own home. Handling normal deliveries herself and referring complications to the obstetrician, she created what was essentially a neighborhood health and consulting center where deliveries took place in a friendly social environment but also were assisted with a high degree of technical skill and safety. Taiwanese traditional midwives also cooperate with gynecologists to provide family planning services. The traditional midwives arrange for patients to have tubal ligations at their birth stations, with the physicians performing the surgery and the traditional midwife providing preoperative and postoperative care. Many help the government to sell contraceptives, making a small profit from these sales.

In Fortaleza, Brazil, birth stations have been organized by Dr. Galba Araujo, a professor of obstetrics at the *Maternidade Escola Assis Chateaubriand*, to the benefit of *parteras empíricas* and pregnant women. Dr. Galba invited the *parteras* to assist their clients in delivery at small satellite centers where a nurse and transportation to a hospital are always available. These *parteras*, who have been taught to identify high risk cases, have not lost a single patient in 5,000 deliveries under this system. The Ceará State Department of Health expects to extend this type of service throughout the state. While building this bridge between modern and traditional practices, Galba is encouraging changes on both sides, including fewer cesarean sections, use of birthing stools, and a more relaxed atmosphere in the university hospital. Cooperation such as this at the working level, whether initiated by the traditional midwife as in Taiwan or the physician as in Brazil, is rarely publicized or evaluated, but shows what constructive results can ensue when both kinds of practitioners recognize their mutual interest in improving the conditions of childbirth and fertility control. They blend good modern medicine with good traditional practices.

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CONTENTS

Volume XIX, Number 2 April 1981

NEWLY INDUSTRIALIZING COUNTRIES

THE EMERGENCE OF THE NEWLY INDUSTRIALIZING COUNTRIES 3
National Planning Association

CHILD NUTRITION

MALNUTRITION: MAJOR CAUSE OF DISEASE AND DEATH IN THIRD WORLD CHILDREN 29
Margaret Cameron and Yngve Hofvander

OVERCOMING MALNUTRITION: THE ROLE OF FATS AND OILS 41
Claire Dearden, Pat Harman and David Morley

LEAVES: AN UNDERRATED SOURCE OF NUTRIENTS 49
H.A.P.C. Oomen and G.J.H. Grubben

SOME ELEMENTS OF A CHILD NUTRITION PROGRAM 59
Margaret Cameron and Yngve Hofvander

COMMUNITY AWARENESS: A STRATEGY FOR ATTACKING THE PROBLEM OF CHILD NUTRITION 69
Save the Children Federation, Inc.

PEDAL POWER

HARNESSING HUMAN ENERGY: PEDAL POWER AND TRANSPORTATION 77
Stuart S. Wilson

HARNESSING HUMAN ENERGY: STATIONARY PEDAL POWER 83
Michael R. Whiteman

DISASTER RELIEF

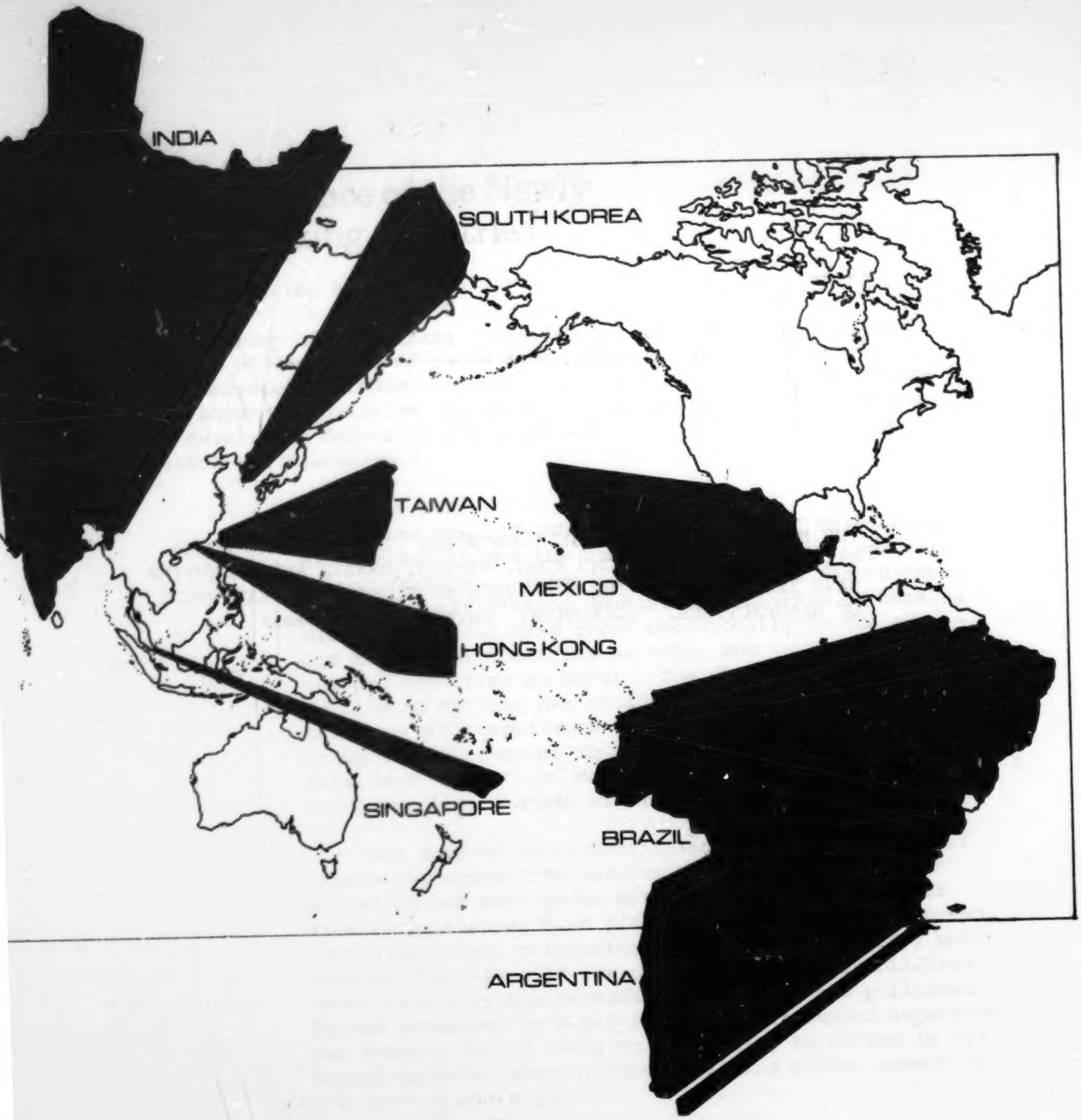
PLANNING FOR DISASTER: THE PREPAREDNESS DIMENSION IN EMERGENCY ASSISTANCE 93
Michael R. Whiteman

EMERGENCY SHELTER 98
Ian Davis

LIVING WITH EARTHQUAKES 110
D. J. Blundell

METHODS FOR SPEEDING FOOD RELIEF IN DISASTERS 119
Mitchel B. Wallerstein

Money values will be expressed in U.S. dollars unless otherwise specified. The spelling "tonne" will be used to indicate metric tonnes (1000 kilograms), and "ton" will refer to traditional U.K.-U.S. tons (2000 lb. or 2400 lb).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NEWLY INDUSTRIALIZING COUNTRIES

THE NEWLY INDUSTRIALIZING COUNTRIES: INDIA, SOUTH KOREA, TAIWAN, SINGAPORE, HONG KONG, MEXICO, BRAZIL AND ARGENTINA HAVE EMERGED SINCE THE MID-1960s AS SIGNIFICANT EXPORTERS OF MANUFACTURES. (Graphics: Barbieri and Green)

The Emergence of the Newly Industrializing Countries

National Planning Association

[A small group of developing countries has emerged as significant exporters of manufactured goods since 1965. Factors leading to their successes in industrial production and marketing, the effects in the advanced countries' markets, and the prospect for these and other developing countries which may become greater exporters in the 1980s are discussed.]

Since the mid-1960s a small group of Third World nations has joined the ranks of significant exporters of manufactures. These nations have been termed the "Newly Industrializing Countries," referred to here as NICs. (We shall also refer occasionally to the advanced industrial countries as AICs, and to the less developed countries as LDCs). The emergence of these developing nations has broadened the number of industrial export competitors in the world economy and brought about changes in the relationship of the industrialized "North" and developing "South" and, even more fundamentally, changes within the South.

For some of these developing nations the level of growth performance in industrialization and overseas marketing has been quite extraordinary. The smaller NICs in particular have within a short time transformed their societies, overcoming much of their poverty, while opening themselves to new problems and vulnerabilities. Aside from possible destabilizing social and political forces generated by rapid change, their export expansion has sharply raised their vulnerability to shifts in external markets, whether from declining market growth or

Composed by the staff of the National Planning Association, an economic research organization, Washington, D.C., including the editors of the Development Digest.

increased protection in OECD importers, or from possible competition from other exporting NICs seeking the same markets. It must be emphasized, however, that these are the problems of success, and that however difficult they may be they can be attacked with a higher level of resources and skills than would have been available in the absence of such successes.

What Constitutes a NIC?

Third World exporters of manufactures can be ranged along a continuum by the value of such exports in a given year, and a cut-off point can be applied at various possible levels to define a NIC. Their rates of growth in the production and/or the export of manufactures should also be considered. A study by the OECD works with a relatively restricted list of NICs: Brazil and Mexico from Latin America; Greece, Portugal, Spain and Yugoslavia from Southern Europe and the Mediterranean; Hong Kong, the Republic of Korea (South Korea), Singapore and Taiwan from East and South-East Asia. A study done by Britain's Foreign and Commonwealth Office (FCO) worked with a wider list, adding Argentina to the Latin American group; Israel and Malta in the Mediterranean; and India, Malaysia, Pakistan, Iran, the Philippines and Thailand on the Asian list. In addition, it suggested that Poland, Romania and Hungary from Eastern Europe deserved analysis under the NIC classification. This study concentrates on South Korea, Taiwan, Hong Kong, Singapore--the so-called "Gang of Four"--and India in Asia; Brazil, Mexico and Argentina make up the Latin American component; the European NICs are not included. The nations listed constitute the eight largest among the non-European Third World exporters of manufactures in 1976.

Table 1 shows the enormous jump in the value of NIC exports from 1965 to the mid-1970s, as well as trends in the total export of manufactures by developing countries. Table 2 indicates the rather extraordinary growth rates in the real values of manufactured exports in this period, and their importance in the total exports of these countries chosen for discussion as NICs.

The question at this point is, why have these particular countries been capable of exporting manufactures at such remarkably dynamic growth rates? Is there a set of unique conditions prevailing in these countries which allow them to penetrate OECD markets in manufactures? Or are the developing country NICs simply the first wave of a trend in the pattern of world industrialization which will bring other developing countries into world markets as exporters of manufactures in due course?

TABLE 1

LEADING DEVELOPING-ECONOMY EXPORTERS OF MANUFACTURES

Country or Territory	Value (million current US dollars)			
	1965	1975	1976	1977
Hong Kong (Including re-exports)	989	5,590	7,859	8,911
Taiwan	187	4,303	6,936	7,947
South Korea	104	4,136	6,747	8,498
Yugoslavia	617	2,903	3,382	n.a.
Singapore	300	2,233	2,920	3,496
Brazil	124	2,192	2,332	3,044
India	809	1,961	2,802	n.a.
Mexico	166[b]	2,090[b]	2,000	2,475
Argentina	84	723	975	n.a.
Malaysia	68	664	798	n.a.
Pakistan	190[a]	571	n.a.	n.a.
All developing countries	4,590	35,280	45,580	n.a.
(some European NICs for comparison)				
Poland	1,628	5,758	—	—
Hungary	1,567	4,257	—	—
Rumania	—	2,189 (1973)	—	—
Greece	89 (1968)	1,003	1,252	1,372
Spain	736 (1968)	5,372	6,025	7,203
Portugal	465 (1968)	1,355	1,198	1,385

[a]—Including what is now Bangladesh.
[b]—Including border trade.

Source: UN International Trade Statistics, Volume 1, 1977.

TABLE 2

GROWTH OF MANUFACTURED EXPORTS FROM THE NICs

	Real Average Growth % Per Annum 1965-1975	Manufactured Exports As % of Total Merchandise Exports	
		1960	1977
South Korea	36.0	14	85
Taiwan	28.8	na	49
Brazil	25.4	3	26
Mexico	21.2	12	29
Argentina	16.7	4	24
Singapore	15.0	26	44
Hong Kong	11.9	80	96
India	2.8	45	56

SOURCES: World Bank Staff Working Paper No. 314, The Changing Composition of Developing Country Exports, January 1979, Table 7; and World Development Report, 1980, Table 9.

Factors Contributing to Achievement of NIC Status

Among the eight NICs examined here there is a significant dichotomy. One group is comparatively small in area, resource- and land-poor, and densely populated. It includes South Korea, Taiwan, Hong Kong and Singapore. Development of their export industries was very intensive, undertaken purposefully as a means of economic survival. The other group, consisting of Brazil, Mexico, India and Argentina is more mixed. These countries tend to be large in population and area, and to have had a longer period of industrial build-up and more variegated policies.

There is clearly a considerable diversity in the total group of eight NICs, but it is possible to identify five conditions which affected all of them to some degree and which were conducive to the creation of a NIC.

Condition I: First is the rate of growth in the world economy and the effect that this has had in providing adequate demand for possible NIC exports. Without external buyers for exports, expansion of a manufacturing sector is impossible unless a domestic market can absorb the goods produced. The period from the mid-1960s to the early 1970s was a high growth period, and this is an important element in explaining the timing and extent of the growth in manufacturing of the present NICs.

Condition II: Second, there are certain internal conditions which are more or less common to the NICs under consideration here. One of these factors that the NICs share is an educational level, or at least a stress on educational improvement that sets them apart from most other LDCs. Hong Kong and South Korea currently have over 90 percent literacy rates, very close to the levels found in AICs only 20 years ago. In the larger NICs where literacy rates are not so high, they have been increasing strongly since 1960, and the same can be said of the spread of higher levels of education. In the NICs with large populations, where percentages for various educational levels not appear high, the absolute numbers are sufficient to indicate that there is a "critical mass" of educated elite to propel the expansion of manufactures for export. For example, India's educational performance may not look strong when expressed in percentage terms, but there were over 3.7 million Indians in higher education in the early 1970s--between five and six times more than in Britain. The emphasis that Nehru and his successors placed on scientific and technical education has created a reservoir of highly educated manpower that should continue to strengthen the foundations of the Indian industrial sector.

Condition III. A third factor that the NICs have in common is that they each have had to transform their closed inward-looking, import-substituting development strategies into more open export-oriented ones, at least in some degree. The means by which each of these nations did so is quite different, as was the timing and intensity of the change. An outward-looking development policy can be evidenced by measures taken that improve their responsiveness to world markets and their ability to meet demand in those markets. This responsiveness can take the form of exchange rate adjustments and other monetary policies that favor trade, reduced protection of internal markets, and policies that encourage foreign as well as domestic investment. A variety of export promotion devices may be employed, including not only overt promotional activities but subsidies and taxes designed to guide producers toward potential export sectors and to reward the achievement of foreign sales.

Condition IV. Political stability appears to be a condition necessary for the rapid increase of industrial output and its sustained entry into foreign markets. Not all the NICs have shown 100 percent stability, in the sense of an absence of disruptive changes of government in the post-war years, but some have: Taiwan, Hong Kong, Singapore, Mexico and--with one brief slippage--India. South Korea, devastated by war in the 1950s and subjected to two major coups thereafter, nevertheless had a stable period of over 15 years in which its intensive growth policies were consistently pursued; and the same could be said of Brazil post-1964. Argentina would seem to be the main exception here, as in some other respects; its classification within the NIC category will be discussed below.

Condition V. Finally, a factor bearing on NIC formation should be mentioned, although it cannot be positively termed a necessary condition: a relatively poor natural resource endowment relative to population numbers. The countries that have abundant, readily exploitable minerals and especially petroleum, one or a few well-developed agricultural export products such as rubber, sugar, cotton or coffee, or a favorable timber potential--such countries can generally mobilize these products for export far more rapidly than they could expect to develop the export of industrial goods. This would be the most rational course for them to pursue. But if they do not have such opportunities, and if the other conditions favoring exports are present, then the paucity of natural resources should induce them to begin sooner and more intensively to develop their industry for export purposes.

This proposition cannot be generalized to suggest that poor resources *per se* are helpful to industrialization. But their role in conjunction with other factors can be illustrated as follows: the most unusual successes in NIC achievement are found in the extreme cases of Hong Kong and Singapore; the examples of Korea and Taiwan are similar on a larger scale. At the other extreme are the OPEC countries, from which exports of manufactures have not been prominent although these nations have had the capital to expand industrial development. Less extreme are countries like Malaysia and the Philippines, where some of the other NIC conditions are found but which have lagged relative to others in East Asia in developing manufactures for export given their natural resource-based alternatives. And Argentina, rich in land per capita and with established agricultural exports, is on the margin of NIC status.

These then appear to be five conditions relevant to NIC evolution that may be cited as affecting or characterizing--albeit somewhat loosely--the eight countries selected for discussion. They are not, of course, the full list of conditions affecting the growth of industry in LDCs or the expansion of trade generally. Some additional conditions will be discussed next, to be followed by a brief review of the evolution in the eight countries individually.

Other Factors Bearing on Industrial Exports

For developing countries short on capital and having abundant and low-cost labor, a comparative advantage could be expected from specializing in labor-intensive products and labor-utilizing technologies. A government should therefore be able to increase the competitiveness of its manufactured export sector by controls on labor costs and the collective-bargaining process. Unquestionably this was the basis for some of the NIC successes in export growth; but low labor costs are not sufficient to establish a country's competitiveness. There is a mixed experience in the degrees of labor intensity in manufactured exports from the different NICs. Korea's export experience in the 1960s seems to have been concentrated in labor-intensive manufactures, as was that of Taiwan and Hong Kong. Mexico's trade experience, on the other hand, seems to suggest that its industrial exports are found among products that are somewhat more capital intensive, higher in technology and/or based on mineral resources, rather than in traditional low-technology and labor-intensive processes. Brazil and Argentina seem closer to this pattern; Singapore and India are intermediate.

An important positive factor is the size of an economy. Statistical analysis of individual countries suggests that economies of scale, as well as cumulative experience of one kind or another in production, exporting and related activities, are involved in the successful export of manufactures. Hong Kong and Singapore, of course, started as relatively small economies when they were politically separated from their hinterlands, but they were forced into foreign trade by the absence of alternatives, and they had the physical facilities, skills and experience to become enormously successful exporters.

The role of multinational corporations. Multinational companies can play an important role in transferring AIC manufacturing processes into the Third World. They are also active in the foreign marketing of LDC manufactures, supplying an expertise that is often needed. Evaluation of the contribution of such companies is difficult, however, because figures from different countries on investment by multinationals are not always comparable. We must consider not only the traditional manufacturing multinationals, but also the big retail and mail-order chains (Sears Roebuck, Great Universal Stores, etc.) which have been creating regional purchasing offices in many of the NICs since the 1960s. The best available figures (Table 3) suggest that the multinationals do play a role, but that it varies greatly by country; the Latin American NIC economies have been more dependent on such investment than the Asian NICs other than Singapore. There is some evidence that the Japanese subsidiaries were particularly likely to be export-oriented rather than import-substituting, followed by U.S. subsidiaries (see Table 4).

TABLE 3

THE SHARE OF MULTINATIONAL FIRMS IN THE EXPORTS OF MANUFACTURES FROM SELECTED UNDERDEVELOPED COUNTRIES (Circa 1972)

Country	*Approximate share*	*Year of estimate*	*Total manufactured exports in 1972: millions of dollars*
Hong Kong	10%	1972	2,635
Taiwan	At least 20%	1971	2,489
South Korea	At least 15%	1971	1,351
India	Approximately 5%	1970	1,320
Singapore	Nearly 70%	1970	893
Brazil	43%	1969	749
Mexico	25—30%	1970	647
Argentina	At least 30%	1969	394
Pakistan	5—10%	1972	380
Colombia	At least 30%	1970	172

Source: Deepak Nayyer's 'Transnational Corporations and Manufactured Exports from Poor Countries' in *Economic Journal* March 1978, Vol 88, p.62.

It would be a mistake to put too much emphasis on the multinational phenomenon for NIC creation. The multinationals may be reacting to changes in the world economy, not creating them. One of the best illustrations of this point is provided by the leading American television manufacturer, Zenith. This company led the way in trying to fight off Japanese imports in the early 1970s. However, in the face of the superior Japanese competition (cheaper labor, superior design and production technology, and some alleged dumping), Zenith could hold out no longer. The firm was forced to move its factory operations into

TABLE 4

USE OF LDC SUBSIDIARIES AS EXPORT PLATFORMS

MNCs based in (1971-2)	*LDC subs (= 100%)*	*Export-oriented subsidiaries (50 per cent or more of sales made for export)*	*Export-oriented subsidiaries as a percentage of all subsidiaries*
US (1976)	**2,362**	**323**	**14%**
Japan	**343**	**92**	**27%**
UK	**1,844**	**24**	**1%**
Germany	**645**	**3**	**0.5%**
Netherlands	**310**	**10**	**3%**
Switzerland	**211**	**3**	**1%**

Source: Compiled by Dr L G Franko from Harvard-CEI Multinational Project data.

both Taiwan and Mexico, where there were already other factories that were not subsidiaries of multinationals.

Exaggeration of the importance of multinational companies leads to neglect of the growing entrepreneurial capabilities within the NICs themselves. In all these countries certain local companies are proving to be effective competitors on world markets. The Koreans have their General Trading Companies, led by Samsung, Hyndai, Daewoo and the Lucky Group, with their spectacular success not only in selling industrial goods but in winning Middle Eastern construction projects in the face of considerable competition from established Western companies. An example from Hong Kong is Conic, a purely Chinese-owned electrical/electronic product manufacturer with a 12,000-strong labor force. In India, Bharat Heavy Electricals Ltd. has won key contracts for its products in the middle East. Another Indian company, Engineers India Limited, is a firm of petrochemical consultants with business in Algeria, Iran, Iraq, Somalia, Sri Lanka, Syria and the United Arab Emirates. In Mexico, Hylsa, a private steel company controlled by the Alfa Group has developed the direct reduction steel process, an important technological breakthrough which it has exported to Brazil, Venezuela, Iran, Iraq, Indonesia and Zambia. In Brazil, Mineracoes Brasileiras Reundias is a major iron-exporting firm, controlled by a Brazilian (though supported by foreign capital). This illustrative list serves as a reminder that the AICs no longer have a monopoly of industrial and marketing skills. It is likely that these NIC companies are the forerunners of an increasing number of NIC-based multinational corporations.

Cultural factors. Cultural factors, almost by definition, play a part in the responses of different peoples to economic problems, challenges and opportunities, although there is room for differences of opinion on their nature or importance. It is probably no accident that the four East Asian NICs which have made the most spectacular advances from limited resources are inhabited by ethnic Chinese in three cases, and by people of a closely related culture in the case of South Korea. It may also be noted that the Japanese, stemming from the same larger cultural area, have previously exhibited many of the same qualities as the East Asians now following in their path. The other NICs, however, are either not so simply differentiated from their neighbors (in Latin America), or are so unique (India) as to escape classification. One cannot put forward many generalizations about cultures as representing either scientific or eternal truths; yet, cultural factors of some sort do seem to be involved in NIC evolution.

Other factors. Several additional variables have contributed to countries becoming NICs, including natural resource endowment and location. Natural resources condition industrial choices. Proximity to large markets, and usefulness as ports due to being located on major sea routes, are two ways in which location has aided in the development of some of the NICs.

NICs: Emergence--Case By Case

At this point it is useful to examine how these variables and commonalities in different combination have brought about the development of export capability in manufactures in each of the NICs in question.

In the case of the two city-states, Hong Kong and Singapore, the nature of their physical characteristics, location, and history seem to have dovetailed to make them centers of manufactured exports. Indeed, these circumstances almost required that Hong Kong and Singapore engage in trade of manufactures, as there appeared to be little alternative if they were to exist and grow as independent units, a condition forced upon both by vagaries of history. Theodore Geiger writes: "Hong Kong and Singapore are almost totally lacking in natural resources; their arable land can provide only a small portion of their food supply; nor do they have domestic markets large enough to serve as the initial base for industrialization. Hence, their very existence depends on their ability to import, which in turn rests upon their capacity to earn the necessary foreign exchange by exporting goods and services to competitive regional and world markets."

The geographic characteristics were reinforced by the preceding development of Hong Kong and Singapore as entrepots, which in part grew out of their location. In both cases the British had built them up as modern ports, outlets for productive hinterlands from which they became politically separated, located on busy sea lanes. The financial, communications and distributional skills associated with entrepot functions made Hong Kong and Singapore alert to developments in the world economy, which facilitated their transitions in recent years to manufacturing centers focused on export markets. In both, determined efforts and intelligent policies lay behind the growth successes of the 1960s and 1970s. Hong Kong's *laissez-faire* policies and Singapore's planned development oriented to foreign investment were rather different tactics; both were carried out with firmness and consistency. [See also Development Digest, July 1974, pp. 101-124.]

Both South Korea and Taiwan benefitted from the infrastructure built up during the Japanese occupation of the first half of the 20th century, ending after World War II. In the case of Korea, following the civil war and poor performance of the 1950s, a new government undertook a commitment in the early 1960s to an export-oriented growth strategy. This has led to Korea's rapid industrialization and spectacular performance in manufactured exports. Korea's strategy was predicated on the relatively small size of the domestic market and on its very poor natural resource base. Policymakers became aware that import-substitution industrialization would soon reach an exhaustion point within the limited Korean market, and that significant growth could only be based on an external thrust. A historic commitment was made to an externally-oriented industrial growth objective, and was translated into fiscal, monetary and exchange rate policies which massively increased domestic savings and placed the Korean economy on a competitive footing with the rest of the world. Export incentives were generalized so that comparative advantage could be realized. The policy shift was enduring, due to the nature of the political commitment, so that the element of uncertainty was removed.

Taiwan had much that is similar to Korea in its processes of development, industrialization and export of manufactures. Japanese occupation of Taiwan from 1895 to 1945 provided a substantial injection of investment and human capital and established an infrastructure for modern growth, and the movement of numerous educated Chinese from the mainland to Taiwan after the Second World War furthered this development. A successful period of agricultural development and export growth in the 1950s led rather naturally to and facilitated industrialization and manufactured exports. Policy reforms in 1960 reducing protectionist tariffs, unifying and adjusting the exchange rate, and relaxing exchange controls were of fundamental importance in placing the economy on an outward-looking, export-oriented growth path and on a competitive basis with the rest of the world. Again, similar to Korea, the priority and permanence of these reforms removed elements of uncertainty and engaged other sectors in the endeavor.

Brazil's pattern of industrialization began with import-substitution industrialization in the 1930s and the initial postwar period up to the early 1960s. The new government in 1964 undertook a major shift in economic policy, which at first stressed economic stabilization from 1964 to 1967, then from 1968 on made export-oriented growth, with high priority on manufactured exports, the centerpiece of Brazilian policy. Manufactured exports grew at an average of 25 percent per annum, stimulating Brazilian economic growth which averaged 10 percent per annum for the period up to 1973.

This export-oriented growth phase was in large measure the result of deliberate policy changes in 1968. The Brazilian government shifted to a crawling peg exchange rate, and established an elaborate system of export subsidies, tax exemptions and export credits designed to promote exports. These met with great success, and the 1968-1973 period is now known as the "boom" period in Brazilian economic development. The "boom" peaked in 1973 as productive capacity became fully utilized, and as the oil crisis imposed greater constraints on Brazil due to its dependence on foreign sources for 85 percent of oil requirements. These effects dampened Brazil's export drive and economic growth; there has been substantial recovery, although not all the way back to prior growth rates; then a second oil shock in 1979 further damaged Brazil's situation. But clearly the boom period showed that Brazil has the capacity for dynamic manufactured export growth, and brought Brazil strongly into a leading position among the newly industrializing countries.

Mexico has become an exporter of industrial products on the NIC scale, in part because it has become a successful producer of manufactures for its own markets, but also because of special arrangements with the United States. Mexican industrial policies have generally followed an import-substitution pattern, though not to the extremes found elsewhere. There has not been a concerted export drive, and an overvalued currency inhibited foreign sales during part of the 1960s and early 1970s.

An important portion of current exports of manufactures from Mexico owes a great deal to two special situations relative to the U.S. Nearly half of its industrial exports are products from assembly plants relying in large part on imported inputs from the U.S.; many, though not all of these products are re-exported back to the U.S. under a special provision of the American tariff code which limits duties on re-imports to the value added abroad. About two-thirds of these re-imported products are composed of electronic parts, television and communications equipment. Many of these assembly plants are found in a special border zone established by U.S.-Mexican agreement, and a number of these plants are subsidiaries of U.S. firms. Some 25 percent of Mexican manufactured exports are machinery, much of which is automobile parts and components destined for U.S. markets. Again, special arrangements with the U.S. automobile firms have made this possible. (Note: While it is true that many of these Mexican exports are associated with capital-intensive high-technology industries, the Mexican contribution in such cases may be in relatively labor-intensive segments of the operations.) Future developments in Mexico's trade and industrial growth are certain to be colored by the large new oil exports, the repercussions of which are only now unfolding.

India has become an industrial nation of some consequence since World War II. Its economic plans and policies have tended toward protectionist import substitution, but there have also been export incentives amid the complex regulations. India's low labor costs have made possible the export of a portion of its growing textile industry output, and traditional jute exports have continued. Its heavy industries have been the object of state encouragement, and in some cases a sufficiently high level of quality at competitive cost has been attained to enable export sales in various machinery categories. In recent years financial policies have been liberalized, resulting in somewhat stronger incentives to export. Overall, the rates of growth have been slow relative to those in the other NICs discussed here, but there is the definite potential for sustained and sizable increases in the future.

Argentina gets into the NIC category by virtue of the size of its industrial exports in the mid-1970s, but is not really a "newly industrializing" country. Its period of most rapid growth was prior to 1930; its major period of industrialization came in the 1930s and 1940s as a defensive reaction to the depression in agricultural earnings and the subsequent wartime shortages. This also occurred in Brazil and Mexico; but in Argentina's case the postwar period has been one of political instability and inability to achieve as consistent a rate of progress as the other two nations beyond the relatively high per capita income already attained. Nevertheless, the nation was able to effect a brisk increase in industrial exports between the mid-1960s and 1970s under the strong stimulus of new tax and exchange rate incentives. Some of these exports were processed agricultural products, but others were machinery and automotive products, many going to other Latin American countries with some help from LAFTA (Latin American Free Trade Area) arrangements. Subsidiaries of foreign firms were active in this development, but indigenous enterprise participated too. The 1974-75 period brought a set-back. The new government since 1976 has been moving toward economic stability, and total exports have grown but mostly in agricultural products; an overvalued exchange rate, together with Argentina's high-cost labor have been inhibiting the export of manufactures. The near term outlook depends on the joint incentive results of various, sometimes contradictory, taxes and exchange controls.

Two major patterns of NIC formation emerge from this review: the small economy of limited resources intensely mobilized for rapid achievement; and the larger, more diversified economy which achieves NIC status at a more leisurely pace as a byproduct of an industrialization program largely guided by import-substitution policies. Brazil moved from the second into the first category--at least in the intensity of its growth thrust. Other developing countries have also shifted from inward-looking to more export-oriented policies during the late 1960s and 1970s, but none with a success on the scale of Brazil.

Potential NICs

To round out this analysis of NICs in the developing world, it is useful to consider briefly some of the countries which have approached but have not so far attained this designation—recognizing, of course, that the borderline for using the NIC label is an arbitrary one. Some of the most likely candidates for the next tier of future NICs would include Malaysia, the Philippines, Thailand and Pakistan in Asia, as well as such "sleeping giants" as China and Indonesia: Colombia, Chile, and Peru in Latin America; and Algeria, Egypt, Turkey and Iran in the Middle East--with Saudi Arabia as a specialized case. (Again, Europe is omitted from consideration.)

Malaysia, despite successes in export of rubber, tin and now oil, is also moving into a diversity of industrial markets; its policies are reasonably favorable to exports. Pakistan has developed textile markets plus a few specialties. The Philippines and Thailand, traditional exporters of sugar and timber, and rice and timber respectively, have been more inward-looking in policy, and have been less fortunate than Malaysia in maintaining political stability; this last would be true in Pakistan as well. In Indonesia, the traditional exports of rubber and timber, etc., now massively augmented by oil, have so far overshadowed any potential manufacturing for export. As for mainland China, while its industries have grown on a very large scale they have been almost entirely designed to supply the growing domestic needs, and their international competitive qualities are untested except in a few consumer goods categories. The potential for large scale export of manufactures appears to exist for the longer run, and some shifts toward a more outward-looking policy have occurred recently; but it will take further policy reorientation and a number of years before this potential can be realized.

Of the Latin American candidates, the closest to NIC status may be Colombia, where industrial growth has been appreciable but exports have been dominated by agricultural products. Peru, following a drastic shift from an import-substitution policy to an export-oriented policy in the mid-1970s, recently increased manufactured exports more than eight-fold--from $105 million in 1975 to an estimated $850 million in 1980. Increased textile exports account for the majority of this increment, but there have also been increases in the export of cement, metal products and processed agricultural goods. Chile, with a smaller population, is showing signs of increasing outward orientation and industrial growth, but is not as fully mobilized for export as the Far East NICs. Venezuela, with its oil resources, is under no current pressure to export manufactures.

The last general observation would apply to several of the Middle Eastern countries which have displayed recent growth in industrial production. Iran, which has had a considerable investment in factories, seems unlikely to get stably organized soon, and in any case can fall back on its oil to earn foreign exchange. If Iran lost its oil-exporting capacity, it might be forced into a strategy emphasizing manufacturing, but the internal situation is very unpredictable and Iran is an unlikely NIC candidate in the 1980s. Algeria, too, can fall back on its oil exports, but has been building an industrial capacity which may eventuate in exports in time. Turkey and Egypt have no oil exports to count on; both have moved ahead with industrial development, especially Turkey, and for longer than the oil exporters. But in neither case are policies sufficiently outward looking, nor are efficiency levels such that they could ensure success in the export of manufactures without greater policy change. Lastly, Saudi Arabia with its vast oil sales has no current need of industrial exports; but it is building some new industrial enclaves for the future, with emphasis on petrochemicals, and can afford to install them quite rapidly. How this experiment will turn out is not yet clear.

In sum, the countries of the Third World that have not yet become significant industrial exporters include a few (e.g., Malaysia, Colombia) where the potential may be close to realization; but in most cases the absence of one or more of the five conditions listed above is holding them back. One of the conditions applying to all countries, the growth rate in the world economy, is likely to be somewhat less favorable to would-be exporters of manufactures in the 1980s than in the 1960s and early 1970s. Probabilities for political stability and export-oriented policies are difficult to predict, and the 1980s could be a difficult period in this respect too. The extent of protectionism surrounding the larger OECD markets is similarly uncertain.

Table 5 supplies basic statistics on NICs and near-NICs.

Disadvantage of NIC Status

It should be kept in mind that the NICs, as a result of success in industrial exports, stand out from other LDCs in the following ways:

1. NICs are more dependent on world markets than are other LDCs as a result of their commercial successes. This makes them more vulnerable to fluctuations in these markets. (This may be less true in the case of India.)

2. NICs have been affected on a larger scale by OPEC price moves than have other LDCs. NICs are more dependent on imports generally to maintain growth, and this is especially true of oil imports. (Mexico is an obvious exception with respect to oil.)

3. NICs have been the heaviest borrowers from banks among LDCs since 1973 because of efforts to obtain high-cost

TABLE 5

BASIC DEVELOPMENT INDICATORS OF NICs AND NEAR NICs

BASIC INDICATORS

Country	Population (millions) Mid-1978	Area Thousands of Sq. Km.)	GNP/Capita ($) 1978	GNP/Capita Avg. Annual Growth (%) 1960-78	Avg. Annual Rate of Inflation (%) 1960-70	Avg. Annual Rate of Inflation (%) 1970-78	Adult Literacy Rate (%) 1975	Life Expectancy at Birth (Years) 1978
NICs								
India	643.9	3,288	180	1.4	7.1	8.2	36	51
Hong Kong	4.6	1	3,040	6.5	2.3	7.7	90	72
Singapore	2.3	1	3,290	7.4	1.1	6.1	75	70
Rep. of Korea	36.6	99	1,160	6.9	17.5	19.3	93	63
Taiwan	17.1	36	1,400	6.6	4.1	10.3	82	72
Mexico	65.4	1,973	1,290	2.7	3.5	17.5	76	65
Brazil	119.5	8,512	1,570	4.9	46.1	30.3	76	62
Argentina	26.4	2,767	1,910	2.6	21.8	120.4	94	71
Near NICs								
Thailand	44.5	514	490	4.6	1.9	9.1	84	61
Philippines	45.6	300	510	2.6	5.8	13.4	87	60
Colombia	25.6	1,139	850	3.0	11.9	21.7	81	62
Chile	10.7	757	1,410	1.0	32.9	242.6	88	67
Malaysia	13.3	330	1,090	3.9	-0.3	7.2	60	67
China	952.2	9,597	230	3.7	--	--	--	70
Pakistan	77.3	804	230	2.8	3.3	14.6	21	52
Peru	16.8	1,285	740	2.0	9.9	22.2	72	56
Algeria	17.6	2,382	1,260	2.3	2.3	13.4	37	56
Eygpt	39.9	1,001	390	3.3	2.7	7.0	44	54
Turkey	43.1	781	1,200	4.0	5.6	21.5	60	61
Indonesia	136.0	2,027	360	4.1	--	20.0	62	47
Iran	35.8	1,648	2,160	7.9	-0.5	23.7	50	52
Saudi Arabia	8.2	2,150	7,690	9.7	--	28.4	--	53

Source: World Development Report, 1980. The World Bank, 1980, pp. 110-111.

oil, and to maintain their fast growth rates in the face of sluggish markets for their exports. Therefore, the NICs have built up unprecedented large debts. But they are not generally the chief risk-problem countries from the banks' standpoint, due to their unusual exchange earning capabilities.

Impact of NICs on the Advanced Industrial Countries (AICs)

Questions now arise as to how the emergence of NICs affects the economies of the more established industrialized countries. What AIC manufacturing sectors have been most affected by NIC competition? How has improved economic performance by NICs affected their role as AIC customers? Do these advances in NIC commercial success constitute a threat to AIC markets? These impacts, as seen from within the AIC economies, may have important consequences for the NICs themselves, as well as for potential future NICs.

Export sectors. LDC exports of manufactures have been concentrated among a few exporting countries (i.e., NICs) as noted earlier; they also have been concentrated in a relatively few industries. In 1974, over one-half of LDC exports of manufactures to all developed countries were centered in just three industrial sectors: textiles, clothing, and electronics and electrical machinery (see Table 6). LDC exports

TABLE 6

PRODUCT COMPOSITION OF DEVELOPING-COUNTRIES' EXPORTS TO DEVELOPED COUNTRIES AND TO OTHER DEVELOPING COUNTRIES, 1974

Product Group	To Developed Countries	To Other Developing Countries	Percent Going to Developed Countries[b]
Textiles	14.5%	18.1%	54.3%
Clothing	21.0	5.5	85.9
Electronics and electrical machinery	15.7	6.0	82.3
Other machinery and transport equipment	3.0	20.9	21.2
Chemicals	9.6	15.5	51.5
Iron and steel	4.7	6.2	57.9
Other manufactures	31.4	26.8	67.6
Total	100.0	100.0	63.4

[a] Yugoslavia is counted here as a developed country.

[b] Taking into account exports (not shown) to centrally planned economies.

Sources: U.N., *Monthly Bulletin of Statistics* (May 1977); and Donald B. Keesing, "World Trade and Output of Manufactures: Structural Trends and Developing Countries' Exports" (Washington, D.C.: World Bank, 1979), p. 33.

to the United States show only slightly less concentration: in 1976, the same three sectors (including footwear with clothing) accounted for 49 percent of the $15.4 billion of total U.S. imports of manufactures from LDCs. No less than 75 percent of all U.S. imports of manufactures from LDCs in 1976 were accounted for by these sectors plus leather goods, nonferrous metals and miscellaneous manufactures, such as jewelry.

In at least one of these sectors of noteworthy OECD imports from LDCs, textiles (i.e., fibers and fabric, excluding clothing), import penetration was more than compensated for by increasing exports. Throughout the latter 1970s the United States had a slight positive balance of trade in textiles while the EC and Japan had still more favorable balances in textiles (see Table 7). Clothing, however, was quite a different matter: the United States and European countries, and to a lesser extent Japan, had large and growing negative trade balances in clothing over the same period. Of the major OECD countries, only Italy and France had positive trade balances in clothing.

TABLE 7

NET TRADE IN TEXTILES AND CLOTHING IN SELECTED COUNTRIES, 1973, 1976 AND 1977

(Billions of dollars)

	Textiles			Clothing		
Country	1973	1976	1977	1973	1976	1977
U.S.	– $0.36	$0.32	$0.17	– $1.88	– $3.05	– $3.45
EC	1.97	1.47	1.70	– 0.89	– 2.75	– 2.68
France	0.29	– 0.27	– 0.13	0.45	0.13	0.19
Germany	0.30	0.30	– 0.07	– 1.63	– 2.72	– 2.99
Italy	0.62	0.80	1.15	1.11	1.85	2.24
Japan	1.32	2.39	2.84	– 0.20	– 0.37	– 0.41

Source: GATT, *International Trade, 1977/1978* (Geneva, 1978), p. 59.

Import penetration relative to markets. The total values for imports of manufactures from all LDCs, including NICs, has been less than one percent of gross domestic product for most OECD countries, and in no case over 2 percent. Thus, despite the rapid recent growth in such imports, the overall job displacement impact on AICs is so far small relative to shifts in employment due to domestic cyclical swings or technological changes.

In a few industries, the effects have been more important. Generally these are among the most labor-intensive activities--clothing, footwear, leather goods, certain electrical products where hand assembly is important. Much of the labor employed in these industries tends to be relatively unskilled and immobile, and therefore hard to absorb in other industries even in periods of expansion. Many of these workers are elderly; many live in relatively stagnant regions of their countries; many work for vulnerable small firms. For all these reasons, the job losses hit politically sensitive nerves, and rouse demands for protection against imports. The important question, however, is to what extent job losses in affected sectors resulted from imports (from NICs or elsewhere) rather than from other causes. We will not attempt to analyze causes here; suffice it to say that a number of causes other than imports can be found, and that these have had substantial impact.

LDCs as customers. The NICs may represent a potential threat to segments of some U.S. and European industries, but they offer growth opportunities for others. From 1970 through 1976 the NICs took more than six percent of total OECD exports of manufactured goods, amounting to $465 billion annually. For all non-oil LDCs the total reached 14 percent of OECD manufactures in 1976. As rapidly as AIC imports of LDC manufactures grew during the early 1970s, it is clear that advanced-country exports of manufactures to LDCs grew even faster (see Table 8). The growing incomes of LDCs, especially in the NICs, were increasing their demands for many of the AIC products.

TABLE 8

THE RICH WORLD'S TRADE IN MANUFACTURES WITH THE POOR, 1972, 1974, 1976, AND 1977

(Billions of dollars)

	United States's			European Community's			Japan's		
	Exports	Imports	Balance	Exports	Imports	Balance	Exports	Imports	Balance
1972									
Oil LDCs	$ 2.0	$ 0.1	$ 1.9	$ 5.0	$ 0.3	$ 4.7	$ 1.8	nil	$ 1.8
Nonoil LDCs	7.6	6.1	1.5	12.8	4.2	8.6	7.1	$ 1.2	6.0
Total LDCs	9.6	6.2	3.4	17.8	4.6	13.3	8.9	1.2	7.7
1974									
Oil LDCs	4.3	0.1	4.2	11.8	0.6	11.2	5.2	0.1	5.1
Nonoil LDCs	16.4	10.8	5.6	23.5	8.9	14.6	15.2	3.4	11.8
Total LDCs	20.7	10.9	9.8	35.3	9.5	25.8	20.4	3.5	16.9
1976									
Oil LDCs	10.0	0.1	9.8	23.3	0.6	22.7	9.0	0.1	8.9
Nonoil LDCs	18.5	14.8	3.7	25.7	11.1	14.7	16.3	3.5	12.9
Total LDCs	28.4	15.0	13.4	49.0	11.7	37.3	25.4	3.6	21.8
1977									
Oil LDCs	10.6	0.2	10.4	29.7	0.8	28.9	11.6	0.1	11.5
Nonoil LDCs	19.1	16.9	2.1	30.4	13.1	17.3	20.5	3.7	16.8
Total LDCs	29.6	17.1	12.5	60.1	13.9	46.2	32.1	3.8	28.3

Note: "Balance" figures may not equal exports minus imports due to rounding.
Sources: GATT, *International Trade*, various issues, and discussions with GATT officials.

In the late 1970s these trends slackened somewhat. Policymakers in the NICs chose to reduce growth, and to restrict imports and promote exports even more than before. Faced with the oil price increase of late 1973, the industrializing LDCs had suddenly had a balance-of-payments constraint to growth. During 1974 and 1975, however, they were able to borrow heavily from the private banks and the Eurodollar markets where OPEC had placed its surplus funds. In 1976 and 1977, fears of over-extension led private banks gradually to reduce their net lending to nonoil LDCs: U.S. Treasury figures indicate a decline from $11 billion to $5 billion between 1976 and 1977. Simultaneously, countries such as Brazil followed advice to "tighten their belts," and initiated a policy of import reduction by levying large new tariffs or by tightening quantitative or government purchasing restrictions on top of already existing high-tariff protective structures. Because of the relatively short term of many of the debts incurred by the NICs, these countries attempted to accelerate the already rapid growth of their exports of manufactures in order to earn the foreign exchange with which to service and pay back these loans. Export subsidies, and "performance requirements" on approval of new investments (requiring that they achieve minimum export levels) proliferated.

From the point of view of the developed countries, it might be asserted that the NICs have succeeded all too well in coping with the difficult economic management problem handed to them by the OPEC oil price revolution, even though Brazil and Mexico continue to have debt-service-to-export ratios which are considered very high by historical standards. The advanced countries' problems should be kept in perspective, however. To summarize:

1. LDC exports of manufactures have been disruptive only in a few specific sectors, due to their concentration by product group.
2. The impact of LDC penetration in the OECD countries' markets for textiles, clothing and electronics appears to have been small relative to the impact of such domestic phenomena as inadequate investment in physical and human capital in the advanced economies, and the penetration of imports from Japan in other OECD markets for autos and steel.
3. The deterioration in advanced-country trade surpluses with the NICs after 1977 was, in large part, due to a forced pace of increase in NIC exports, accompanied by the NICs' choices of policies favoring lower growth and restriction on imports, in reaction to the oil price shock. The strength of that reaction can be traced primarily to the short- and medium-term maturity structure of the NICs' debt incurred in world financial markets as they attempted to cope with that shock.

The NICs in the 1980s

Two rather different views of the NIC phenomenon can be recognized. One is that there is a one-way historical process at work, common to all countries in their economic development, which brings about changes in comparative advantage over time; this leads to shifts in the composition of output, and eventually to changes in the pattern of exports. In this view, the emergence of the NICs is part of a changing world economic structure corresponding to shifts in the international division of labor among countries. These changes are seen as a generalized historical movement, in which the most advanced industrial countries vacate intermediate sectors in industrial production with the more advanced developing countries moving into these sectors. These advanced developing countries in turn move labor away from the more basic industrial sectors in which the next tier of developing countries is engaged. This view, then, suggests that the present necessity for AICs to adjust to growing NIC competition is a tip-of-the-iceberg kind of problem because the historical process of industrialization will continue to spread, and the number and growth dimensions of new NICs will continue to increase.

The other view sees the emergence of NICs in the past decade or so as a process of concentration of industrial capacity in particular countries characterized by special circumstances that made high-volume, dynamic expansion of manufactured exports feasible. It is also a process dependent on a rapid growth in world trade, without which new NICs could not emerge. This view suggests that the development of substantial industrial capacity of significance in the global structure of production and exports occurs in particular circumstances which lead to a major thrust toward the world market in manufactures. This process is essentially concentrated in a limited number of countries in which the necessary conditions are present, rather than found in a wide variety of countries. The implication of this view for the future is that the need for AIC adjustment to NICs as it emerged in the 1970s may have been greater than is likely in the 1980s in terms of the number of newly industrializing countries capable of playing a global role in world trade in manufactures.

Neither of these views of the issue has an exclusive hold on the truth. To a very considerable extent, both the implied processes may be going on simultaneously. Nevertheless, it is useful to highlight the differentiation of these two views, so that in looking to the future judgments can be reached as to the relative weight of the various forces affecting the shape of LDC-OECD trade relations in manufactures in the 1980s.

To a certain extent, the relative weight that one would assign to the forces moving toward country concentration as compared to those toward country spread would be determined by the degree to which one is taking a global perspective. The term NIC is by definition applied to a country of significance in world markets in terms of volume and growth in total industrial exports. Conversely, to the degree to which one is taking a sectoral perspective, one is concerned with disruption and displacement of particular industries derived from the cumulative penetration of foreign imports from whatever source. There is also the question of how one foresees the rates of growth in OECD countries through the 1980s.

The forces working toward concentration of industrial capacity in a limited number of countries appear now (as of 1981) to be more important in defining industrial trade adjustment between the OECD and developing countries than are the more generalized historical forces for industrial spread. If this view predominates among OECD policymakers, the danger of their imposing new trade restrictions during the 1980s will be lessened. However, this prospect also depends on the economic growth that will prevail in 1980s. It is easier to accept and adapt to new foreign competition when growth is proceeding well than in a recession; imports look far more threatening when total jobs and profits are being reduced.

Another tier? As Table 9 indicates, the 1976 magnitude of manufactured exports from the "next tier" of developing countries was quite small relative to that of the eight NICs. For example, manufactured exports from the five countries in the next tier in East Asia, which includes some of the most promising newcomers--Malaysia, Thailand, the Philippines, and Indonesia--together comprised less than 10 percent of the volume from the East Asian NICs in 1976. The twenty-two countries from all regions in the next tier, taken together, constitute less than twenty percent of total NIC manufactured exports in 1976. It would take a growth rate of 20 percent a year over a nine year period in these countries to attain the value of manufactured exports in 1985 that the eight NICs achieved in 1976. World trade expansion will probably slow in the 1980s, and it is unlikely that first tier NIC manufactured exports will in fact grow more slowly than exports from the next tier; even if they did, the first tier NICs would still remain the predominant exporters among developing countries in 1985.

The dynamism of the expansion of exports from the leading industrial sectors in the NICs during 1965-75 was generated, in our view, by a combination of circumstances and conditions which dovetailed in an unusual way to bring about a major thrust by these countries toward world markets. In each case this surge in manufactured exports was also the result of a highly deliberate national effort. The key elements in the emergence of the NICs--particularly the four East Asian NICs and Brazil--seem to have been political and social in character, leading to a societal commitment to an export-oriented growth strategy based on manufacturing for foreign markets.

TABLE 9

MANUFACTURED EXPORTS FROM THE NICs AND THE NEXT TIER OF DEVELOPING COUNTRIES: 1976

(U.S. Dollars)

				(1975)	
EAST ASIA					
NICs:	Hong Kong	6,480a/			
	Korea	6,747			
	Taiwan	6,921			
	Singapore	2,920			23,068 Total
NEXT TIER:	Malaysia	799			
	Thailand	511			
	Philippines	397			
	Macau	207			
	Indonesia	119			2,033 Total
LATIN AMERICA					
NICs:	Brazil	2,332			
	Mexico	2.327			
	Argentina	976			5,635 Total
NEXT TIER:	Jamaica	345	Guatemala	155	
	Colombia	384	El Salvador	200b/	
	Venezuela	150b/	Dominican Republic	120	
	Trinidad & Tobago	122	Costa Rica	119	
	Uruguay	170	Chile	150b/	
			+20%	149	2,064 Total
AFRICA					
NEXT TIER:	Morocco	202			
	Tunisia	203			
	Bahrain	200			
	Senegal	200b/			
	Ivory Coast	134			939 Total
SOUTH ASIA					
NICs:	India	2,803			2,803 Total
NEXT TIER:	Pakistan	677			
	Bangladesh	220			987 Total
NICs:					31,506 TOTAL
NEXT TIER:					5 933 TOTAL

Source: Donald B. Keesing, World Trade and Output of Manufactures: Structural Trends and Developing Country Exports, World Bank, January, 1979, Annex B

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a/Excludes re-exports. b/Estimates based on figures in previous years.

Conclusions. These trends suggest that the dovetailing of favorable economic conditions with externally-oriented political and social forces is less likely to be a generalized phenomenon over, say, twenty or more countries than to be limited to a few unusual countries. This is not to say that export growth is not possible for a number of countries, but that only a few can expect to expand at a Brazilian-Korean pace. Secondly, the trends suggest that the *internal* history of individual countries is more powerful in generating the kind of national commitment required to become a NIC than are the external historical forces behind the generalized spread of industrialization globally. Thirdly, the NIC formation process will need growing world markets, along with high employment in AICs and willingness to accomodate required structural change; and these will not be as prevalent in the 1980s as in the 1970s.

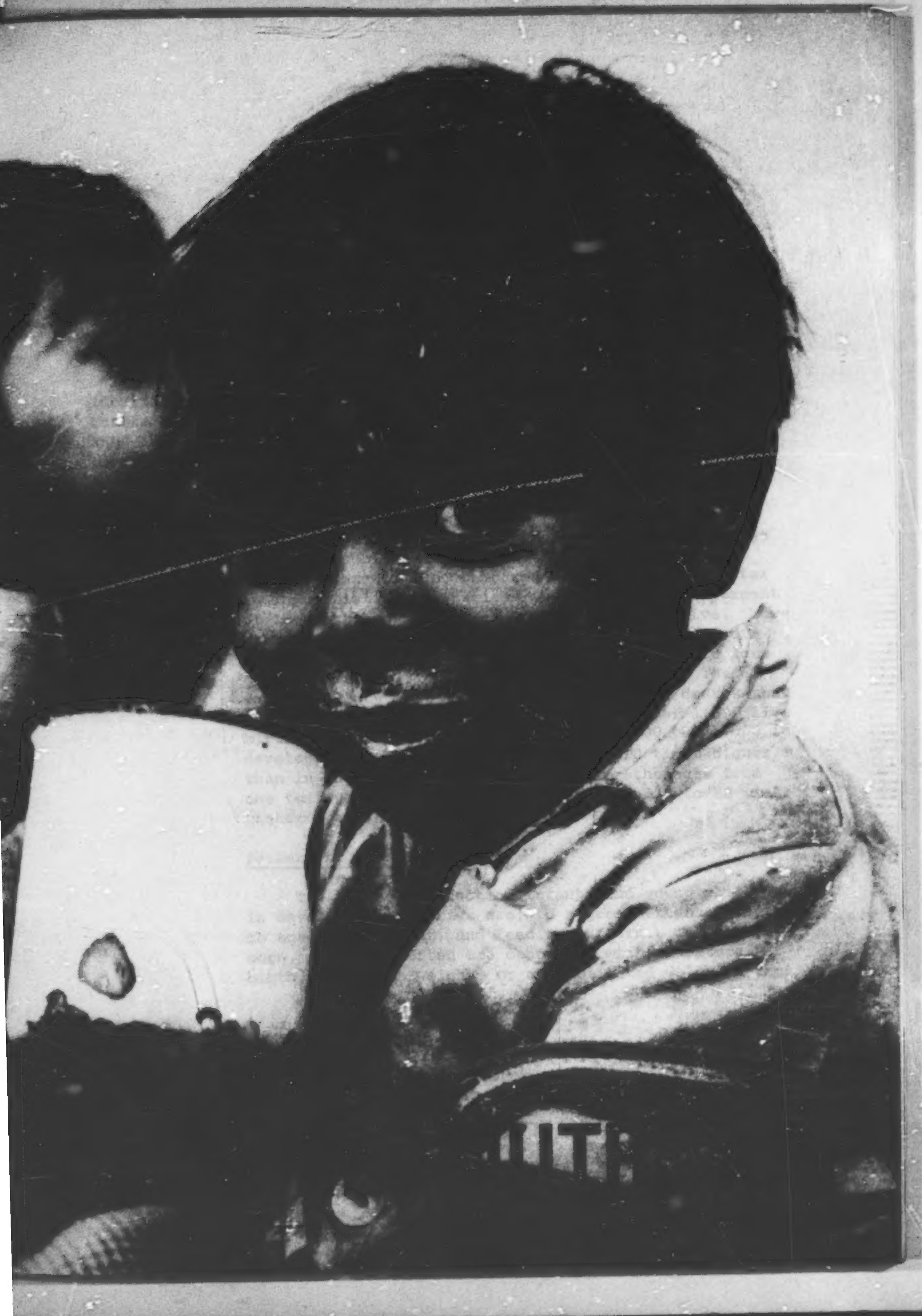
Finally, the rise of manufactured exports from developing countries has a self-reinforcing nature in the process itself. These reinforcing qualities would appear to operate both internally and externally. Internally, the managerial, marketing, design and entrepreneurship qualities needed for successful exports of manufactures are of the learning-by-doing variety, and would therefore tend to be spun off from one set of activities to another. Once Korean manufacturers, for example, learned how to penetrate the U.S. market for electronic calculators in a major way, they could move on to color television sets with greater ease than could other countries who have been marginal exporters. The importance of these qualitative capabilities to operate cumulatively has to be a factor enhancing the tendency for country concentration in manufactured exports.

On the external side, foreign investors, international banks and multinational corporations tend to gravitate to countries with bright economic prospects. It is a feature of creditworthiness considerations that favorable foreign financial flows go to countries already doing well, permitting them to do better, while other countries, needing the external resources more, have difficulty attracting foreign commercial funds. Hence, both internal and external factors tend to operate in a way which concentrates resources, creating a dynamic climate in which success breeds success. Obviously this does not go on indefinitely without change, but it is a powerful short run force.

The implications of these points for the future are that the NICs are likely to keep their leading positions in the first half of the 1980s at least. It is possible, however, that a second and smaller wave, composed of Malaysia, Colombia, Chile and possibly the Philippines, could emerge toward the end of the decade. China could well become a real Third World competitor in the 1980s depending on the evolution of its policy orientation, although indications so far don't point to a development of this status much before the last decade of this century.

Another possibility for the 1980s, one on which past experience provides less guidance, is that the growth dynamic which has so far depended heavily on AIC markets may increasingly operate in the trade of developing countries with one another. The NICs will, obviously, have a leading role in this development, insofar as it occurs. To pursue this direction of growth would require some reorientation of policies on the part of both the NICs and their potential trading partners, so that the potentials may be realized and expanded. Just how to do this may become a major challenge of the 1980s.

[Adapted from Chapter 1 of The Newly Industrializing Countries in the World Economy, Report of the National Planning Association for its British North American Committee, publication forthcoming 1981.]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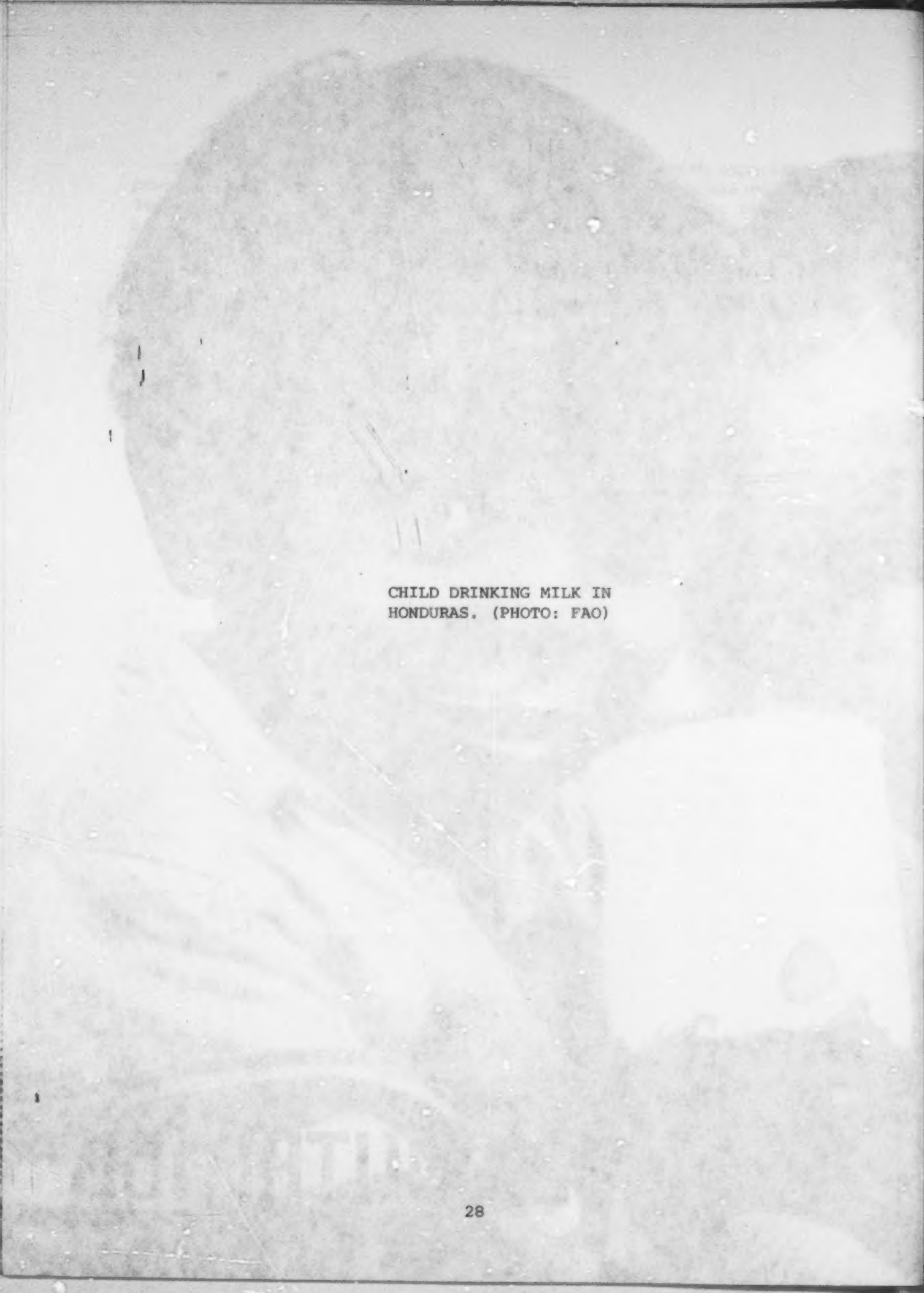

CHILD DRINKING MILK IN
HONDURAS. (PHOTO: FAO)

Malnutrition: Major Cause of Disease and Death in Third World Children

Margaret Cameron and Yngve Hofvander

[Certain maladies are caused directly by nutrient deficiencies. Others are the indirect result of malnourishment; the body is weakened and less able to resist disease, infection and parasite infestation. This article deals with both of these types of malnutrition, and with the preventative measures that might be taken.]

Most developing countries have a high percentage of young people--almost half the population is less than 15 years of age, compared with about one-quarter in industrialized countries--and some 15 to 20 percent of the total population is under the age of five. However, more than 50 percent of the total deaths occur in children under five years of age, compared to less than 20 percent in Europe and North America. The infant mortality rate--that is, the number of deaths that take place during the first year of life per 1,000 live births--usually ranges between 100 and 200 per 1,000 in developing countries, which is nearly 10 times higher than in industrialized countries. For the ages from one to four years, mortality ranges from 30 to 50 times higher than in Europe and North America.

Pattern of Diseases

The diseases affecting infants and young children in developing countries are, to a great extent, related to age, environment, and feeding pattern. In the newborn, illnesses often are connected with premature birth, low birth weight, or a complicated delivery that

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causes birth injuries or breathing difficulties. Often it is difficult for a prematurely-born infant or an infant with retarded fetal growth to suck the breast, maintain body temperature, mobilize sufficient sugar for energy, and resist infections, particularly in an unhygienic home environment. Such infants may not survive.

The newborn is extremely susceptible to infections from both the mother's birth canal and the environment. Breast milk contains specific antibodies that protect the infant from these dangers during the first days and weeks of life. Any other food given at this time could be hazardous. Such foods as butter, cow's milk by bottle, and various other mixtures that sometimes are thought of as strengtheners often will cause disease.

In the postneonatal period--that is, after the first month--the baby's health continues to depend on unsupplemented breast-feeding, provided, of course, that the mother can supply enough of it. If supplementary feeding, particularly bottled cow's milk, is started during the first few months, diarrhea will most certainly appear, and other infections and infestations will be more prevalent. Serious lung infections include whooping cough, tuberculosis, and those that follow and complicate measles. Measles, which can have serious effects for all children, is particularly dangerous for those in developing countries because it affects preschool children who may be malnourished to a greater or lesser degree. This group's death rate from the disease is about 5 to 7 percent. Malaria is another threat; in areas where that disease is endemic, it starts to affect young children at a few months of age.

From a few months of age, intestinal worms and parasites start to inhabit the intestines of infants, and some may affect their health adversely. For instance, hookworm causes anemia and *Giardia lamblia*, a parasite, causes diarrhea and affects the ability to absorb nutrients from food. Thus, many different diseases affect the health of infants and young children in developing countries; but the diarrheal diseases and malnutrition are most important from a public health point of view.

Diarrheal Disease

Diarrheal disease is the greatest killer of infants and young children. Studies made in India and Guatemala showed that the incidence of diarrhea seems to increase rapidly soon after infants are given food in addition to breast milk; the incidence is particularly high in the second year of life ("weanling diarrhea"). The same studies also revealed that diarrhea is more common in undernourished than in normal children, and that the more severe the undernutrition the more frequent and severe are the diarrheal episodes. This is often the condition if sanitation is poor. On the other hand, it has been shown that the incidence of diarrheal disease in a community decreases sharply when food supplements are given.

In severely malnourished children, damages in the intestinal mucosa (the mucous membrane lining the inner surfaces of the intestine) impair food digestion and absorption. Malnourished children who suffer repeated episodes of diarrhea may also have become intolerant to lactose, or milk sugar, due to a lack of the enzyme lactase, and so react badly to a milk diet. Infections outside the intestines--pneumonia, ear infection, or malaria--may also lead to vomiting and loose stools, although usually these symptoms are not as severe as those from true intestinal infections. In only about 20 percent of all diarrheas is it possible to identify a specific causative agent, such as bacteria, a virus, or a parasite. Attacks of diarrhea can also be caused by an intake of too much indigestible food. Some foods, such as beans, may be poorly prepared and cooked; hot foods, such as chillies, may cause irritation in the intestines, as can some traditional herbal medicines.

Every patient with watery diarrhea has some dehydration and needs replacement fluid. Dehydration may be mild, moderate, or severe. Patients with milk dehydration appear almost normal, even though they might have lost 25-50 ml/kg body weight. The young child with severe dehydration is likely to lose 100 ml/kg body weight or even more. As fluid is lost, signs of dehydration (e.g., thirst, increased pulse rate, sunken eyes, inability to pass urine, etc.) develop rapidly and so should be treated quickly. Unless it is caught while the symptoms are still mild, it will worsen and become more difficult to manage.

Thirst is the only early sign of dehydration. Infants show their thirst by crying and being eager to drink any fluid given to them. When dehydration is mild, patients may first appear normal, but, as dehydration increases, they become restless and weak. Finally, they become dazed, then unconscious, their bodies become limp and their hands and feet become cold. This condition is called shock. Loss of body fluids cause the tissues behind the eyes to shrink, so the eyes appear sunken and dry. In infants, the soft spot on the top of the head sinks. The pulse rate increases and the strength of each beat weakens.

The most important treatment for diarrhea is the following: 1) *Rehydration*--Replace the water and salts lost in the stools. This treatment should be completed within six hours. 2) *Sustenance*--Continue to replace losses of water and salts so dehydration does not return. Start feeding the usual diet, whether breast milk, cereals, or other weaning foods. Treat other infections or complications.

Give drugs if, and only if, needed. This treatment should continue until the diarrhea stops.

Starvation is especially harmful during an illness such as diarrhea. Breast-feeding should continue if the child is on breast milk, but other food should not be given until the child is able to eat. This period, however, should be as short as possible and not last more than six to 24 hours. Many young children with diarrhea are already poorly nourished, and loose stools may in some cases be, in part, the result of malnutrition. If the infant is not able to suckle, it is advisable to discontinue breast-feeding for a short period--a day or so--during which time the mother's milk should be extracted, the infant should be returned to the breast as soon as possible. In partly breast-fed infants, the supplementary foods, like cow's milk or a gruel, should be stopped temporarily and replaced by rehydration fluids.

After a short period of intestinal rest, small, frequent feedings should be started. These may consist of diluted boiled milk, preferably skimmed, or soured milk, prepared either locally or commercially. The feedings should be increased in amounts and strength over the next day or two, and followed by such foods as gruel, porridge, or mashed bananas. In the most uncomplicated cases, the child should be back on a normal diet in three to four days. Some children may have successive diarrhea attacks when fed cow's milk especially in dried, skimmed-powder form. For such children, cow's milk should be avoided if other foods are available as sources of energy and protein but, if it must be given, quantities should be limited to about 150 ml, diluted with clean boiled water or glucose-salt solution, given every four hours.

It is important to follow up on undernourished children who have recovered from an acute attack of diarrhea. As long as they remain malnourished they are at risk for more of the disorder, as well as from infection, further malnutrition, and death. Drugs are not usually needed in mild or moderate cases of diarrhea, but one of the less-absorbable sulfa drugs, such as sulfaguanidine, may be used. In severe cases of dehydration, administration of fluid is much more important than drug therapy. The decision to use drugs should be left to the doctor or the medical assistant.

Deficiencies in Energy, Protein, and Other Nutrients

Certain vitamin--and mineral--deficiency diseases occur with varying frequency in infants and small children. These include avitaminosis A, rickets, and iron-deficiency anemia. The incidence varies greatly from place to place, depending upon both the local dietary pattern and cultural factors. In some countries, eye damage resulting from vitamin-A deficiency is reported to occur frequently. If this is a problem, an injection of vitamin A should be given to the child to help prevent blindness. The vitamin-A deficiency disease xerophthalmia, which may lead to blindness, may be prevalent despite the presence in the area of vitamin A-containing foods that are not eaten in the normal meals because the inhabitants of the region do not know their value (see article on leaves below).

Protein-energy malnutrition (PEM) is the most common form, and is seen during the transitional period of weaning. It is the world's principal public health problem and, if unchecked, will leave many children permanently handicapped both physically and mentally. The nutritional status of young children runs downward from normal, to mild, to moderate protein-energy malnutrition, with severe syndromes, such as kwashiorkor and nutritional marasmus at the bottom. Some of the relevant symptoms are illustrated in Figures 1 to 6. In developing countries, the majority of young children pass through either a mild, moderate, or severe form of PEM during the weaning, or transitional period. The desirable rate of weight increase, which may represent the general development, is illustrated in Figure 1. During the first few months, the infant develops well, provided there is a good flow of breast milk. From four to six months of age, or even earlier, growth falters and the weight curve flattens. This is due to the combined effect of inadequate diet and infection. Some infants develop a more severe type of malnutrition, which may be a nutritional marasmus, kwashiorkor, or some intermediate form. The infants who get sufficient energy and nutrients in their food have few infections and develop well.

Typical marasmus is seen in the infant in Figure 2. The sufferer is usually less than one year but may be older, has severely retarded growth, and a low weight for age, usually below 60 percent of the standard weight. The muscles are markedly wasted. They are "flabby," which is often best felt on the thighs and buttocks, where the muscles should be thick and strong. Because the subcutaneous fat (fat under the skin) is poor or almost absent, the skin is loose and seems to be too big for the body. Nearly always, such an infant has an "old man's face" or a "monkey face." A marasmic patient does not have haircolor changes and there is no edema (an excessive accumulation of fluid in the tissue; bloating) as is the case with kwashiorkor. In addition, there may be associated signs of various vitamin deficiencies, depending on the local dietary pattern.

A child with typical kwashiorkor is shown in Figure 3. This disease usually occurs in children one to three years of age. Growth is retarded and muscles are wasted and flabby, but the subcutaneous fat usually is not as poor as in marasmic children. Some "sugar babies" may even be fat, indicating a sufficient or more-than-

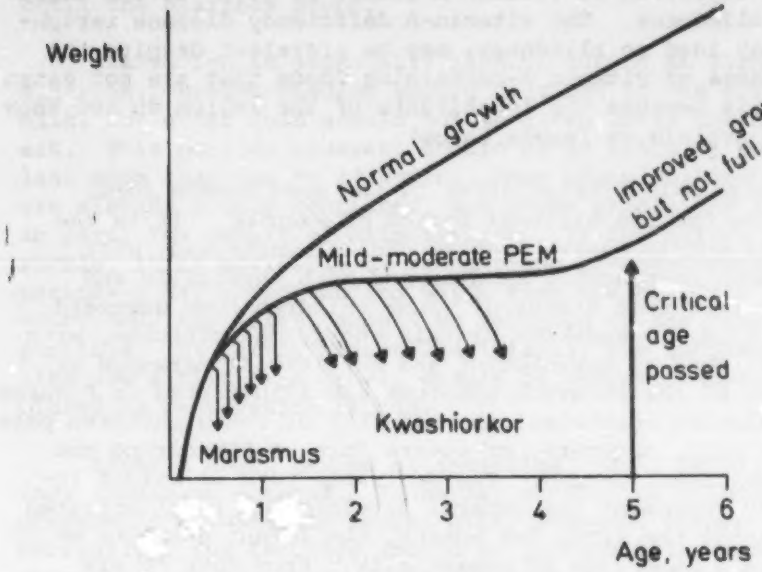

Figure 1. Effect of protein-energy malnutrition (PEM) on growth.

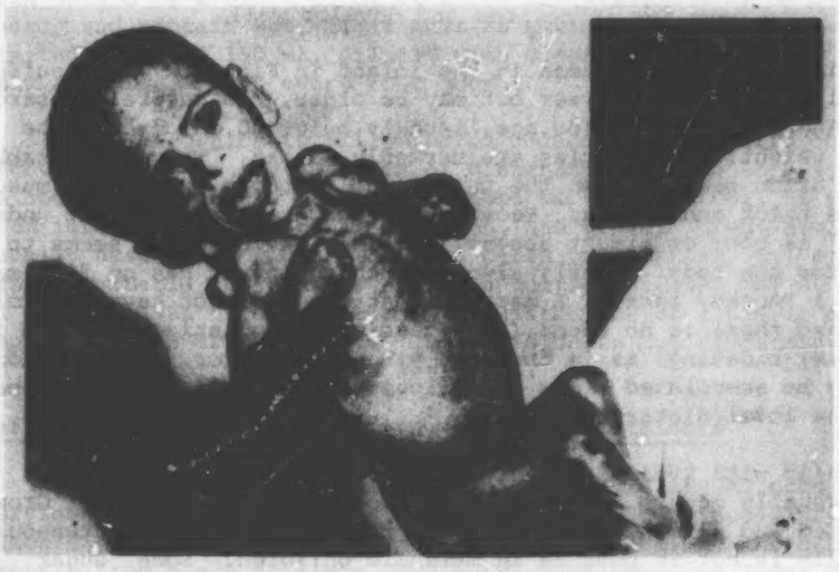

Figure 2. One-year-old child with typical nutritional marasmus.

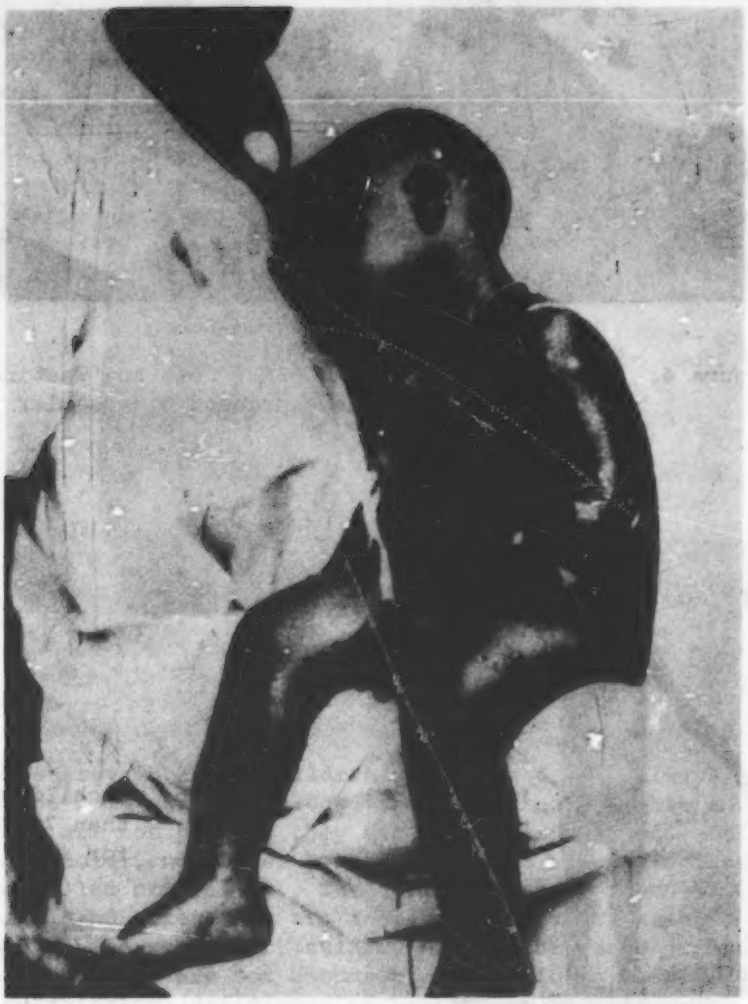

Figure 3. A child with typical kwashiorkor.

Figure 4. A child with moderate PEM. Note the wasting of muscles, which is expressed by muscular weakness.

Figure 5. A child with less than 70% weight for age.

Figure 6. Same child having recovered, now with more than 90% weight for age.

sufficient energy intake. Children with kwashiorkor always have edema, mainly on the feet and lower legs, and they are miserable and apathetic. Because they are not hungry, they are difficult to feed. Often the hair changes color, sometimes even to gray; it becomes sparse, straight, and can be pulled out easily. The children appear "moon-faced," their skin is pale, and often they are anemic. In severe cases, a "flaky-paint" rash may be seen, particularly around the large joints. Intermediate cases of PEM are not uncommon; and children suffering from marasmic kwashiorkor (deficiency of both protein and calories) are often seen.

Children who are improperly fed during the weaning period have a mild or moderate form of malnutrition. This is indicated by low weight-for-age and by other subnormal body measurements, such as height, arm circumference, and head-to-chest ratio. An examination may also reveal wasted muscles, hair-color changes resembling those seen in kwashiorkor, and apathy (see Figure 4). Such children may be precipitated into a more severe malnutrition, such as kwashiorkor, by an attack of measles, a diarrheal disease, or pneumonia. Prevention is better than cure; but treatment of undernutrition, as shown, for example, in Figure 5, should result in recovery, as shown in Figure 6.

Screening for Malnutrition

Prevention of disease is, of course, one of the most important tasks in world health. The prevailing deficiency diseases and infections, so common in infants and children in developing countries, undoubtedly are preventable to a great extent, largely by existing means. An important task of the staff, particularly at MCH (Mother and Child Health) centers and at "under-5 clinics," is to trace those children who are in danger of becoming malnourished, so that the development of serious deficiency disease can be prevented. Such clinics, however, usually serve a large number of patients, and it may be difficult to screen out for special care those children who run the greatest risks of developing serious illnesses.

Weight charts. When a child is under five years of age, weight is the best method of assessing the state of nutrition. It requires considerable skill and experience, however, to decide from a single examination or weight measurement--or even a series of weight measurements--if a child is growing satisfactorily.

The best and simplest way is to plot the weight on a specially designed weight chart, shown in Figure 7. At each visit to the MCH center or the under-5 clinic, the weight is plotted on a chart. With some training, auxiliary staff can do this easily. Charts such as these have been tested by WHO in many countries and have been proved to be of great value. They can also be worked out locally. Because weight is related to age, difficulties may arise in those areas where mothers are uncertain of their children's age, but information can be obtained with reasonable accuracy, at least for infants and small children, by relating the date of birth to local events. The construction of a calendar of local events that will be known by the majority of the community is useful for other purposes, as well.

Flattening of the child's weight curve is the earliest sign of PEM, and may precede clinical signs by weeks or even months. In some places, the mother keeps the chart and the clinic tells her the significance of the lines on the chart. The upper line usually represents the median of the local or international standard weights,

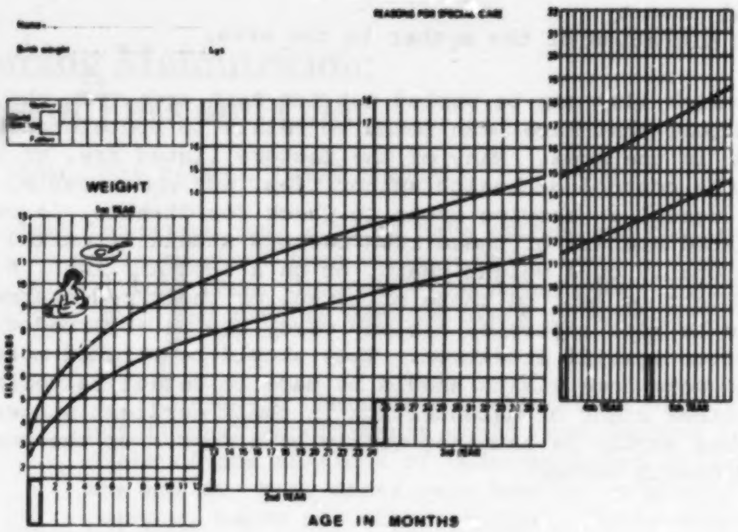

Figure 7. A model weight chart for use in MCH and Under-5 clinics in developing countries. (WHO, Geneva.)

and the lower line indicates 80 percent of that standard. In other places, the weight chart is kept at the clinic; in still others the mother keeps a duplicate copy of the clinic's chart. The arrangement that is best depends on local conditions and the degree of cooperation by the mothers.

High-risk factors. Various studies have identified certain high-risk factors that have shown some relationship with the child's nutritional state. These include:

Low birth weight.
Twins or multiple births.
High birth order.
Death of siblings, particularly if before 12 months of age.
Measles, whooping cough, and severe or repeated diarrheal episodes in the early months of life.
Death of either parent, a broken marriage, or an unmarried mother.

Illiteracy of mothers, in areas where there is a fair degree of literacy, and low intelligence.
General poverty.
Recent migration of the mother to the area.

A high-risk list can be worked out for each area. It should be based on factors that have been found to relate to protein-energy malnutrition in the area. Many of the factors listed are, of course, not within the control of health authorities, nor undesirable, but they may be useful as showing areas to check for disease. A child with designated numbers of these risk factors should be marked by a red star, probably on a weight chart, or on a special list. A "red-star book" might be kept on these children, or their red-starred charts could be kept separate. In any case, the red-starred children should be given special attention. They should be weighed more frequently, and more home visits should be made to detect faltering growth and other signs of malnutrition in their earliest stages. If possible, they should be examined weekly by a doctor or the most experienced health worker.

[Extracted from Manual on Feeding Infants and Young Children, Chapter 4. Published by the Protein-Calorie Advisory Group of the United Nations System, New York, 1976.]

Note: This manual is available in English, Spanish and French editions, and can be obtained from local offices of WHO, FAO or UNICEF, or from FAO Headquarters, Via delle Terme di Caracalla, Roma, Italy. A 1981 edition of the manual is currently being prepared.

Overcoming Malnutrition: The Role of Fats and Oils

Claire Dearden, Pat Harman, David Morley

[Over the last ten years many studies have emphasized that energy deficiency is more important than protein deficiency in the etiology of malnutrition. This paper discusses the advantages of increasing the quantity of oils and fats in weaning diets in developing countries.]

Currently there is a great debate over what nutritional requirements would best improve the diets of the millions of undernourished children in the world. Many diets rely heavily on wheat, rice, cassava, maize and other staples. These staples, when cooked, are bulky and have a low energy density. Small children have difficulty eating sufficient quantities of these foods to meet their daily requirements for energy. The addition of a small amount of a high energy food such as an edible oil to a cooked staple increases the energy density, and has an important softening effect on the food. This means that less water needs to be added during cooking to provide a food of a soft consistency that can easily be eaten by a young child. Supplements of oil or fat in the diet are thus highly desirable.

In many developing countries fats and oils, especially in their processed form, are expensive. Where oil-rich foods such as groundnuts and red palm oil are locally available, they can make an important contribution to the child's weaning diet.

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The Weaning Period

By our definition, the weaning period starts with the addition of foods other than milk and ends when breast feeding ceases and the child is wholly on a general diet. In developing countries weaning usually spans a period from age four months to about three years. This is the time when a child's growth is most likely to become inadequate if given too little nutrition. The child's intellectual potential may also be reduced in this period due to inadequate nutrition; the proportion of the child population so affected is uncertain but may well be considerable.

Common weaning diets in developing countries consist of a gruel (pap or porridge) made from cereals or starchy tubers. The significant difference between the composition of breast milk and these weaning foods is in the fat content. In breast milk, fat contributes 52 percent of its total energy, whereas with most cereal staples only 2-10 percent of total energy is fat-derived. Fat is a concentrated source of energy having more than twice the energy content of carbohydrate and protein.

Advantages of Fats and Oils

The purpose here is to emphasize that the addition of fats and oils not only has the advantage of increasing the energy content of a weaning gruel, but also has an important effect on the viscosity of the gruel. A gruel of given consistency, if it includes oil, can be made with more of the staple and less water, and thus it achieves a higher energy density.

Bulk. Traditional weaning diets are frequently bulky, and young children under the age of three have difficulty in eating sufficient amounts to meet their energy and protein requirements. Small children, because they are growing, require twice as much energy per kilogram of body weight as an adult. Their small stomachs can take only limited quantities at a time, and even increasing the frequency of meals may not raise the total food intake sufficiently. This problem is clearly demonstrated by Rutishauser and Frood's study of young Ugandan children recovering from malnutrition. The figures in Table 1 show the comparatively low energy intakes of children eating the traditional weaning diets, despite the fact that in this study they were fed as much as they wanted five times daily. A similar study by Jones and Pereira showed an inadequate energy intake by pre-school Indian children offered as much as they could take of a high cereal diet. At home children of this age are fed only once, twice, or at the most three times daily. Low intakes of energy and protein are therefore to be expected. Children eating the milk-based diet with its high fat content ate less solid food and yet achieved higher protein and energy intakes.

Table 1

THE PROBLEM OF BULK IN TRADITIONAL HOME WEANING DIETS

	Traditional Weaning Diets	Milk-Based Diets
% Energy from fat	2-18%	66%
Intakes of Children Aged 1-3 Years		
Mean daily intake of solid food (g)	717(± 83)	330(± 45)
Mean daily intake of energy (kcal per kg body weight)	98(± 10)	138(± 6)
Mean daily intake of protein (g per kg body weight)	1.9(± 0.2)	2.5(± 0.1)

Source: Rutishauser I.H.E. and Frood, J.D.L. (1973), British Journal of Nutrition, Vol. 29, p. 261.

When it is impossible to raise the quantity of food consumed (Figure 1) because of its inherent bulkiness, increasing the energy density is the only way that the energy intake can be improved. Fats and oils provide 9 kcal (kilocalories) per gram compared to 4 kcal per gram from carbohydrate or protein, and when included in the diet have the greatest impact on dietary energy intake. Perhaps the improved nutrition, growth, and general health of children in Europe and North America owes much to the increase in the consumption of fats and oils over the last 150 years.

Viscosity. Weaning involves a transition from a fluid to a solid diet. At first the weaning child is able to tolerate only soft semi-solid food. Unfortunately, in order to achieve a gruel of soft consistency, the mother over-dilutes the food. The viscosity is thereby reduced but the child receives too little energy. Viscosity is affected by four main factors:

Dilution. Adding water reduces the viscosity but also lowers the energy content of the weaning food. In order to meet energy requirements, a one-year-old child may need to consume four liters daily of cereal gruel which has been diluted to a drinkable consistency (95 percent water). This dilution will result in an energy density as low as 0.25 kcal/g.

Solubility. In general, cereals absorb more water than tubers to produce a gruel of the same consistency. An example of this in

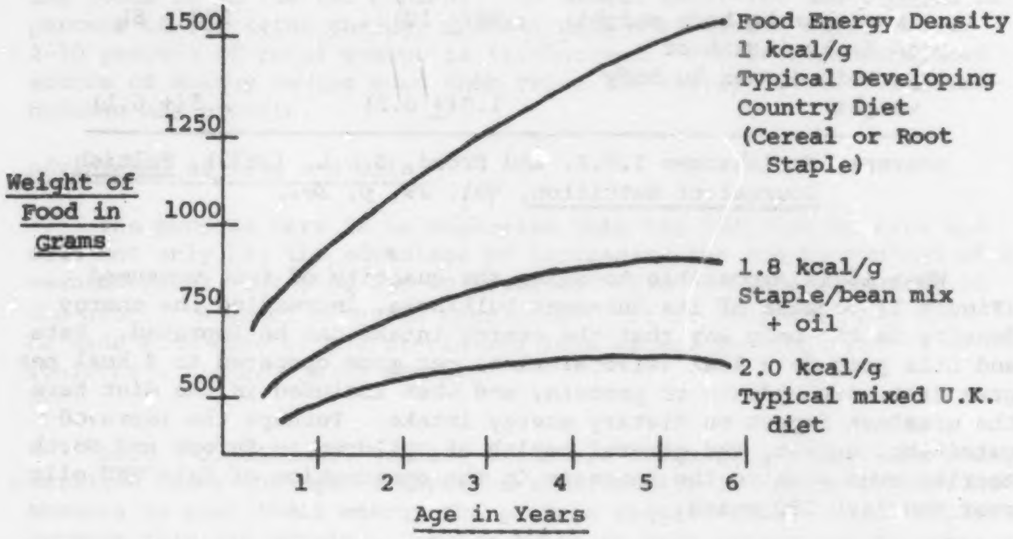
European cooking is the use of cornstarch as a thickening agent in custard.

Temperature. Temperature and viscosity are inversely related. Most food is eaten at around 35°C, at which temperature a maize gruel with even 90 percent water content like a custard is still a semisolid.

Fat Content. Addition of fat or oil to a staple diet has a dramatic softening effect, producing a liquid gruel at a lower temperature and/or lower dilution level.

Figure 1

FOOD INTAKES IN RELATION TO ENERGY DENSITY



Source: Adapted from C.W. Binns, unpublished study on palm oil, 1975; and Rutishauser and Frood, op. cit.

Figure 1. These curves illustrate the difference in food bulk required to achieve the same energy intake in three different diets for children ranging from one to six years old. To illustrate: in order to achieve the same energy intake, a 2-year-old child in a developing country (top curve) needs to eat twice the weight of food of a largely staple diet as a 2-year-old eating a U.K. diet (bottom curve). However, by adding oil to a developing country diet mix (middle curve), the energy density can be improved, making it similar to that of a typical mixed U.K. diet.

Dietary Constraints

The suitability of adding fats and oils can be considered under four subheadings.

1. Nutritional requirements. In planning a weaning diet for developing countries, the main objectives are to ensure adequate growth with sufficient surplus energy to allow the child full activity. The following nutritional requirements need to be met:

Estimates of daily protein and energy requirements. At one year of age, 5.4 percent of a child's total energy should be contributed by protein. A child's requirements are 1.35 g of protein (as protein which is 100 percent utilized) and energy requirements are 100 kcal per kg of body weight.

Protein/Energy ratio. Although energy is important and oil provides concentrated calories, the need for protein also remains important. Fats should not be fed in such high proportions that the protein/energy ratio of the food mixture becomes too low.

Excess fat in the diet. Because of its high satiety value, addition of too much fat as an energy-rich supplement may mean the child's appetite is satisfied before all the food is eaten. Protein and other essential nutrients such as minerals and vitamins may be wasted in the unfinished portion of a meal.

Dietary fats and essential fatty acids. Unlike adults, the child under two cannot easily manufacture fats from carbohydrates, which makes fat an important dietary component. Fats also contain essential fatty acids which are necessary for growth of cell structures. Of the energy supplied to the child, three percent should be in the form of essential fatty acids.

2. Physiological suitability. *Utilization of fat.* Young children eating low-energy-density diets of some developing countries may have an energy deficit ranging from 20 to 30 percent of recommended allowances, depending upon age. If half this deficit were met by an increase in added fat and half by an increase in quantity of the diet now being consumed, the total energy derived from fat would be about 25 percent, which is stillwithin the acceptable limit for children. As an example, in Central America maize-bean based diets fed freely to children ages 15-30 months fulfilled the protein and energy requirements when the diets contained 27 percent of their total energy as fat.

TABLE 2

INCREASING THE ENERGY CONTENT OF A SOUTH AMERICAN MEAL FOR A 2-YEAR OLD WITH 2 TEASPOONS (10g) OF OIL

Food	Weight	Energy
Maize (60% extracted)	50g	177 kcal
Kidney Beans	20g	68 kcal
Total Energy of Meal		245 kcal
Add Red Palm Oil	10g	90 kcal
Total Energy of Meal		335 kcal

In this modified meal protein contributes 10.5% of total energy. By adding oil the energy is increased by 37%. Oil supplies 27% of total energy. The energy density of the modified meal is 1.8 kcals per gram (see Figure 1). Such a meal should be consumed three times a day to provide an adequate intake.

Palatability. The taste as well as the consistency of a food will affect most children's appetites and thus the amount they eat. In the weaning period the child adjusts from the bland taste of breast milk with a cereal gruel to the varied flavors of the adult diet. This adult diet may be highly spiced, making it unpalatable, and contain solids which are difficult for the child with few teeth to chew. For these reasons new foods need to be introduced gradually to allow the child to become accustomed to them.

In a nutritional study done by M.A. Church in 1977, he plotted values for foods well accepted by children and found that they fall within quite well defined limits. Dry foods are only palatable if sufficient fat is added or is already present in the food, as in groundnuts; for this reason, oils are used in many traditional diets to improve their palatability. In a study of Highland children in Papua New Guinea, palm oil was added to the weaning diet. Despite their not being used to the strong flavor of this oil, only six percent of the children objected to the taste. Few foods are eaten if they contain more than 60 percent solids as fat. This corresponds well with the physiological limits outlined in Figure 2. In this figure Church has suggested an area he calls the "Palatability Tolerance Zone" based on water, fat, and energy content of foods.

Food Preparation. Grinding and mashing of foods such as fish or groundnuts can make protein/energy-rich adult foods available to the small child. In West Africa ground legume flour may be made into a stiff paste with water and fried in oil, or oil may be added to the flour which is then wrapped in leaves and boiled or steamed.

Other traditional methods of food preparation may successfully improve the energy intake of small children. In a classical study in South India a traditional method used in a rural community was taken to a laboratory and, after thorough investigation and modification, successfully re-introduced to the village. The method involved washing and soaking sorghum grain overnight, malting (germinating) for four days in jute bags, sun-drying, toasting to improve the flavor, and then grinding. The flour from this germinated grain produced a low viscosity gruel with an energy concentration three times that of a gruel made from normal sorghum flour. The period of sun-drying was found to be important as it allowed the amylases (enzymes specific for starches) produced by germination to break down the starch molecules. A similar process was found not to alter the energy concentration of grams (legumes) but did improve their palatability.

Some food preparation practices can be harmful and result in a reduction of the quality of weaning foods. An example of this is *eko*, a starchy pap made from maize in West Africa. Although local uncooked maize has a high fat content of 51 g/kg, preparation of *eko* involves soaking the grain in water for 48 hours and removal of most of the germ and husk. This results in an agreeable white smooth product in which there has been a loss of 81 percent of the fat and 41 percent of the protein. The proportion of energy available from fat is reduced from

11 percent in raw maize to 2 percent in *eko* pap and the child (aged 1-3 years) would need to consume 4-5 liters per day of this food to meet his energy requirements.

Figure 2

DIET ZONES

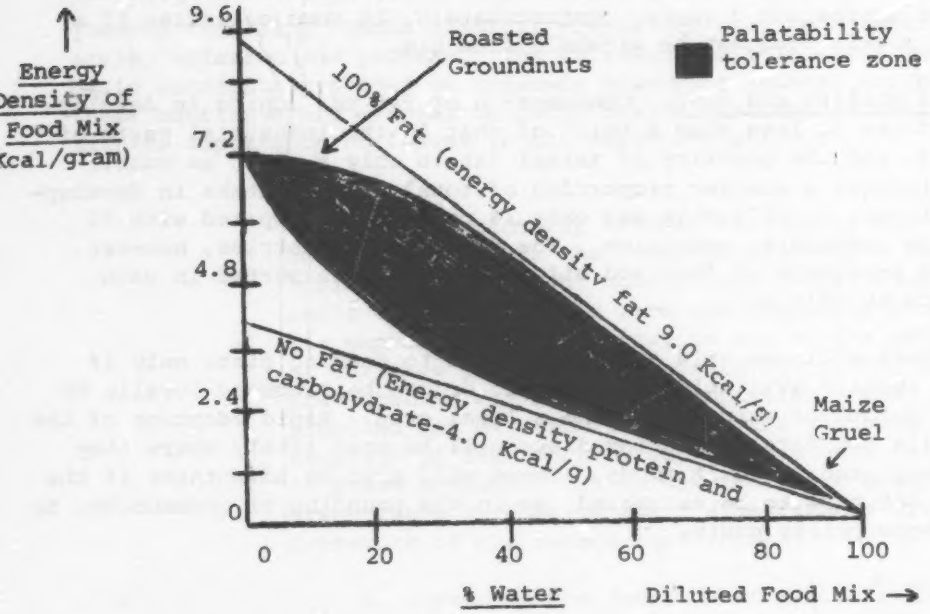


Figure 2. All diets lie within the possible food mix zone (shown by the triangle) and most diets lie within the palatability tolerance zone (shown by the darkened ellipse). They range from roasted groundnuts with high energy density to a maize gruel which may consist of more than 90 percent water and thus have an extremely low energy density.

Source: Church, M.A., The Importance of Food Consistency in Supplementary Feeding and the Weaning Process, 1977, p. 279.

3. Cultural acceptability. *Customs and beliefs.* Changes in the food given in the weaning period will be affected by the villagers' attitudes. Some foods may not be given; for instance, in Malaysia fish is believed to give toddlers worms. In many cultures there are "prestige" foods such as *motoke* in Uganda which, although considered to be a cultural "superfood," unfortunately has a low energy density of only 1 kcal/g. Other areas are more fortunate. In a region of Northern

Uganda a groundnut and sesame-seed paste is used in the traditional weaning diet. This has the advantage that an anti-oxidant in the sesame seed prevents the oil in the food from turning rancid; in areas where this is used the incidence of protein energy malnutrition is lower than in comparable areas.

Food priorities. In many societies men eat first and women and children eat what remains. In these areas small children are likely to miss out on the valuable and limited protein-energy supply. This is particularly so where the young child's appetite is reduced by an infection which is likely to affect him one day in three between the ages of 6 months and 2 years. Unfortunately, in some societies if a child is unwell food may be withheld from him.

4. Availability and cost. Consumption of fat *per capita* in developing countries is less than a third of that in the industrial parts of the world, and the quantity of animal fat is only a sixth as much. Fats contribute a smaller proportion of total energy intake in developing countries; in 1974 this was only 14 percent as compared with 33 percent in industrial countries. The developing countries, however, are large producers of fats and oils; but much is exported in cash crops such as palm oil.

Mothers will use oils and fats to add to weaning diets only if they are locally available at low cost, or can be produced locally by a simple method of extraction from a local crop. Rapid adoption of the use of oils and fats in weaning diets will be most likely where they are already used in adult foods. There will also be advantages if the oil does not have to be extracted, as in the pounding of groundnuts, to make an appropriate paste.

Conclusion

While the volume of food intake depends on the frequency of meals and on the consistency and palatability of food, the nutritive value of that food intake ultimately depends on the energy density and the nutrient content. The main advantages of oils and fats as weaning diet supplements are their favorable effects on food energy density. This is achieved only partly by their high energy content; equally or more important is their ability to decrease viscosity and increase palatability of cereal staples. Most existing weaning diets in developing countries would be much improved by the addition of oil or fat; but the promotion and use of fats and oils in the diets of young children in these countries will depend on their local production, availability, and cost, and particularly the rural people's attitudes toward such foods.

[Extracted from Tropical Doctor, July 1980, Vol. 10 pp. 137-142, Copyright© Royal Society of Medicine, London, England.]

Leaves: An Underrated Source of Nutrients

H.A.P.C. Oomen and G.J.H. Grubben

[Leaves from many common tropical plants can provide essential minerals, vitamins and protein. The following article lists some of the basic nutrients provided in commonly occurring leaves, explains why these nutrients are crucial to child health, and emphasizes the particular importance of leaves in the diet of a child.]

The relationship between health and the uses of herbs is as old as the human race itself. For centuries man has sought comfort and relief from his ailments through products from the vegetable kingdom. Our emphasis here, however, is not on the medicinal or curative properties of plants but rather on their preventative and nutritive properties. What health problems can be associated with the inadequate consumption of leaf vegetables? Who is most vulnerable to these problems? Which nutrients are contributed by green leaves? What is their significance within the framework of the common food intake?

In assessing the function of protective nutritional supplements we soon discover that those who need them most, that is those who are most vulnerable with regard to health, are the rapidly growing small children, and the women whose metabolism is burdened by pregnancy or lactation. In many places in the tropics, the next most vulnerable category is that of the school-age children. How might the addition of even modest quantities (100g or even less daily) of leaf vegetables to the common diet prevailing in the

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less-privileged parts of the tropics affect these groups? This question might best be answered by examining the individual nutrients present in leaves, in order of importance.

Carotene

Carotene is the yellow pigment hidden by the green chlorophyll in every leaf. It is the rudimentary component of vitamin A. When milk, eggs or liver are missing from the diet, leafy vegetables are a critical source of this raw material for producing vitamin A in the body. Vitamin A has many essential functions in maintaining cellular structures in the body; it protects epithelial surfaces (epithelial surfaces are composed of membranous tissue covering most internal body areas, organs and the outer surface of a mammalian body). Vitamin A also promotes growth. At birth the newborn receives a small amount in the liver which then is maintained by breast-feeding. The development of satisfactory liver stores in a child is a vulnerable affair; after weaning, the 2-4 year-olds often develop signs and symptoms of vitamin A deficiency (avitaminosis A). This is manifested by degeneration of the eye surfaces of which destruction of the cornea is the most serious. Such a child, if it survives, will be blind or suffer from serious vision impairment for the rest of its life. This is xerophthalmia (literally: dryness disease of the eye), the worst manifestation of avitaminosis A. Survival in malnourished children, general health, growth and the overall function of body processes, can also be affected.

Since sufficient preformed vitamin A obtained from milk, eggs or liver is rare in diets all over the tropical world, most toddlers in South and East Asia, in Africa, in Haiti and Brazil have to rely on carotene for vitamin A manufacture. The number of children newly blinded from this avitaminosis A has been estimated at about 120,000 a year, and many may have died of associated disorders. Unfortunately, their eyes and possibly even their lives would have been spared if carotene had been present in their daily fare. The tragic irony of avitaminosis A in countries like Indonesia where vegetation abounds was summed up in four words by Dr. Burgess of WHO in 1953 when, discussing the xerophthalmia problem in small children, he wondered at its impact in "so green a country."

Why emphasize leaves? Among roots, carrots, and among fruits, mangoes are outstanding sources of carotene though tomatoes, pumpkins and papayas contain considerable quantities. Unfortunately, the distribution and availability of these fruits and vegetables is much more erratic and seasonal than leaves. In addition, the quantities required, of tomatoes for example, are much higher (see Table 1) and usually so is the price.

TABLE 1

NUTRIENTS IN POPULAR TROPICAL LEAVES, LEGUMES AND FRUITS

(in 100g of dry matter, edible portion: averages of four kinds each)

	protein g	calcium mg	iron mg	carotene mg	vitamin C mg
Leaves	29.8	1114	18.0	38.2	552
Legumes	30.0	153	8.0	0.2	7
Fruits	4.6	117	3.1	4.6	229

Leaves: amaranth, cassava, kangkong, taro
Legumes: peanuts, soybeans, mungbeans, cowpeas
Fruits: banana, papaya, orange, mango

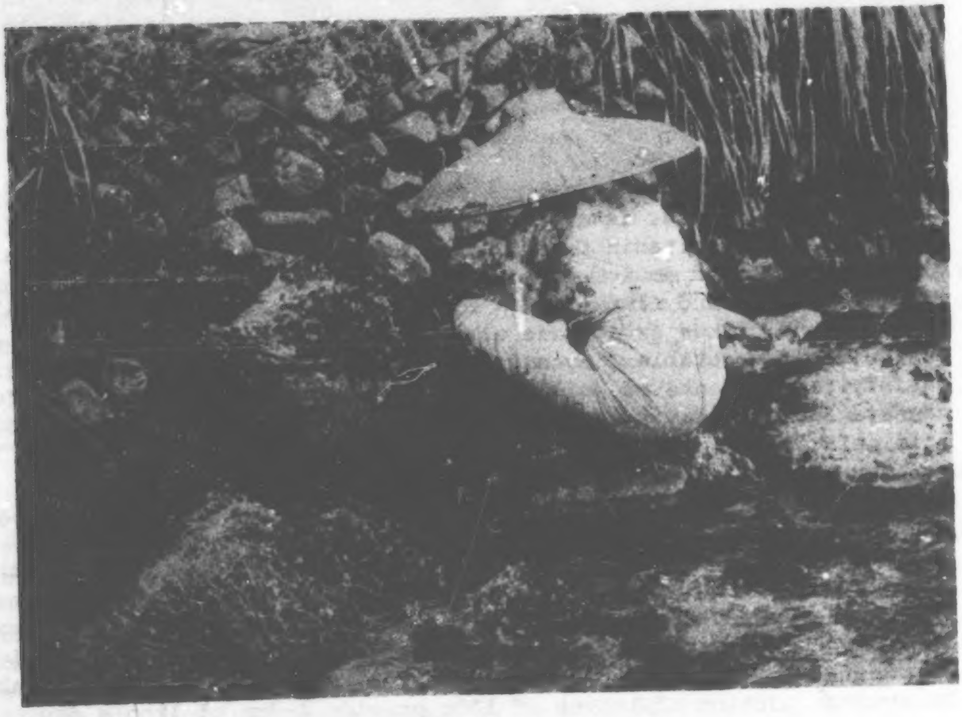

Figure 1. Cultivation of watercress *(Nasturtium officinale)* in the mountainous regions of West Java. The soil is too stony for rice culture and plenty of water is available.

Protein

In the past twenty years the insufficiency of protein intake has been a general concern in the health policies of governments and international agencies. Much of it is centered around the effects of malnutrition in the small child, and the concept of the "protein gap" has been used. But this view of protein shortage as the central cause of nutritional misfortune has been criticized recently. Many believe that the problem is not so much the paucity of protein itself in the diets as the limitations in total caloric intake. Nevertheless, protein is a basic nutrient and an important element in nutritional rehabilitation of the sick or marginally fed child.

The dry matter of leaves contains as much protein as beans, which have a special reputation. Leaf bulk is greater than beans because leaves contain about 70 percent more moisture than dry legumes. A portion of 200g of leaf vegetables may supplement the diet with 6-14g of protein. The nutritional quality of plant protein is different, and for humans usually lower, than that of animal protein. But this can be compensated for by consuming a greater variety of plant products which can provide all the components needed to work together in body-building.

Ascorbic Acid

Scurvy, characterized by bleeding gums, bleeding under the skin and extreme weakness, is a condition brought on by a deficiency of ascorbic acid or vitamin C. All fresh fruits and vegetables contain vitamin C. A good source for infants would be papaya, as the mature fruits are soft and fleshy and they are widely available. Bananas, tomatoes and citrus fruits are also good sources. In the absence of fruits, leaf vegetables, even given in small quantities, could easily satisfy requirements of children and adults alike. For example, four cassava leaves a day would suffice to ward off a state of ascorbic acid deficiency.

Iron

Iron-deficient anemia is a very widespread problem all over the world and small children are quite vulnerable. Iron is found in small quantities in a variety of foods, but the dietary iron actually available for human absorption is generally better when coming from animal sources. If these are absent, the best alternative is leaf vegetables. An average portion of leaves of 100g provide 4-7mg of iron a day, which is sufficient for a small child and a considerable contribution to the recommended daily intake of an adult.

Figure 2. With her baby conveniently on her back, a housewife gathers green leaves of bitter leaf *(Vernonia amygdalina)* from her garden to prepare a meal. Benin.

Folic Acid

Like iron, folic acid is a nutrient responsible for the structure and the function of red blood cells. Folates (folic acid salts) are present in many foods, but only certain animal products and leaves are rich sources. An average portion of 100g of leaves per day would wholly cover a child's minimum daily requirement of folic acid. The same sized portion would cover half of the average adult's daily minimum requirement of 200mcg (micrograms). Pregnant and lactating women have higher than average adult requirements and they are more vulnerable to the type of anemia caused by lack of folic acid.

In industrialized countries, the fortification of common foods is often used to counteract deficiencies of folates, iron and ascorbic acid. The missing nutrient is added to sugar, bread or salt before distribution. However, this approach is often difficult in the Third World, especially in rural areas based on a subsistence economy. These nutrients therefore have to come from the local diet, and a liberal consumption of leaf vegetables is the best insurance against deficiency of these nutrients.

Calcium

Calcium, like other mineral compounds in our food, comes from the soil and is stored in plants. Milk, the sole food of a rapidly growing, skeleton-forming young animal, is a very rich source of calcium. Unfortunately for young growing children in many parts of the tropics, milk is not available in adequate quantities after the breastfeeding ends, and beans and starchy staples contribute only limited quantities of calcium. In these conditions, green leaves can be a common source of calcium to counteract deficiencies. Aside from growing children, a nursing mother loses as much as 300 mg of calcium daily in her milk. The high calcium content of leaves makes it possible to counteract this loss if she consumes between 100-200 g/day.

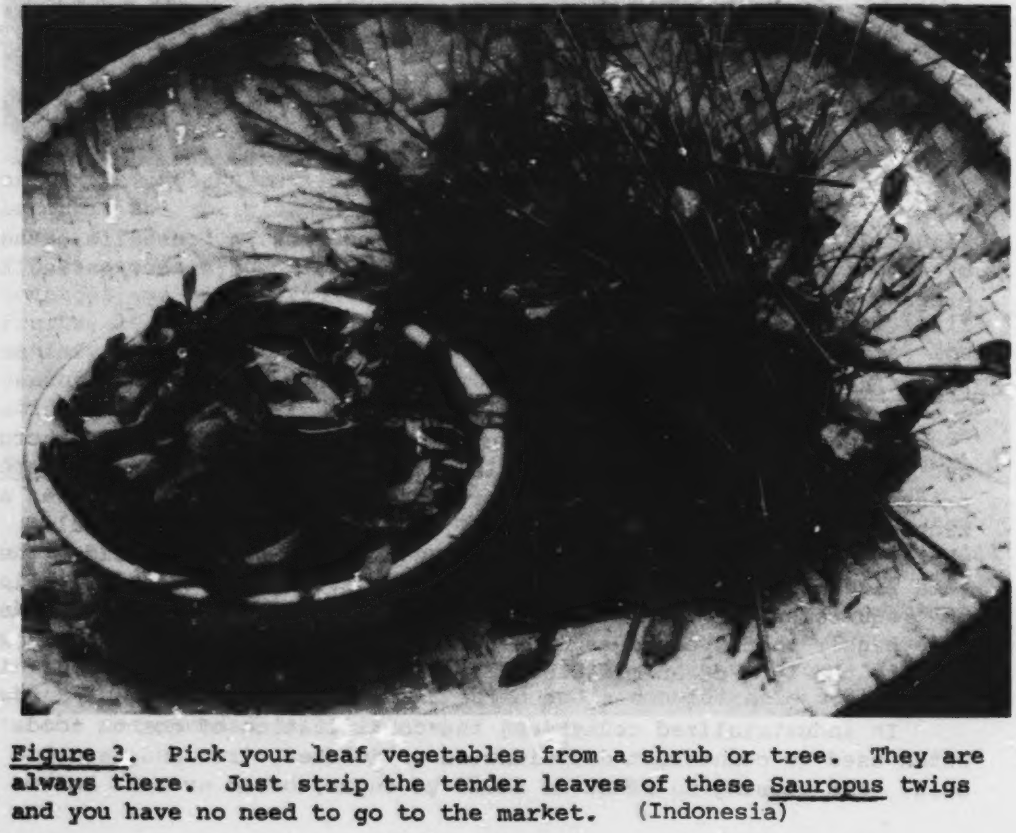

Figure 3. Pick your leaf vegetables from a shrub or tree. They are always there. Just strip the tender leaves of these Sauropus twigs and you have no need to go to the market. (Indonesia)

Quantities of Nutrients Supplied By Leaf Vegetables

What is the practical effect of an average portion of 100g of leaf vegetables on the diet of a typical child in a poor tropical environment? Assume he is six years old, weighs 20 kilograms (44 lbs.), and consumes 1,400-1,500 calories daily. The bulk of his food is provided by the staple, most often rice, maize, wheat or cassava. Assume further that he eats 30g of beans a day, but that milk, eggs, fish or meat do not contribute significantly to his fare. His parents may choose from half a dozen local leaf vegetables. Composition of these leaf vegetables can differ considerably, but something like the following occurs if he consumes 100g daily. (When cooked, 100g does not exceed two heaped tablespoonfuls, so there is little bulk relative to the local staple.)

The protein of the leaves will add 15 percent or more to his total protein intake. The leaves will add over 100 percent to the calcium and iron present in his food. His vitamin A and vitamin C requirements will be 300 percent fulfilled. The B vitamins (thiamine, riboflavin and niacin) would receive a boost of 15-30 percent. The folic acid in the leaves fills his daily requirement. It would be very difficult to quote any other common foodstuff which provides this spectrum of protective effects (see Table 2).

TABLE 2

PERCENT OF DAILY REQUIREMENTS (WHO/FAO) OF NUTRIENTS PROVIDED BY 100g OF A DARK-GREEN LEAF VEGETABLE, e.g., AMARANTH

Nutrients	Quantity Supplied	Percentage of Requirements	
		Pregnant Lactating	Toddlers 1-3 Years
Macronutrients			
protein	4.5 g	11%	28%
Minerals			
calcium	350.0 mg	32%	77%
iron	4.3 mg	48%	57%
Vitamins			
carotene	6.0 mg	200%	400%
thiamine	0.3 mg	25%	50%
riboflavin	0.3 mg	18%	37%
niacin	1.3 mg	8%	14%
ascorbic acid	70.0 mg	230%	350%
folic acid	85.0 mcg	24%	84%

READEX FICHE

This example assumes that the staple food is a cereal. If the staple were fermented or dry cassava, the beneficial effects of the leafy vegetables would be even greater. In case of doubt of the adequacy of particular leaves, just add a little more, and vary the species eaten.

Leaf Vegetables in Infant Foods

It is difficult to give guidelines for the composition and quantities of food for an infant under one. One must first examine the local staple food and review the relevant possibilities. Although leaf vegetables are nutritionally superior, ripe tomatoes or papayas are suitable alternatives.

A source of fat should also be present in the diet. Coconut milk would be a natural source in South and East Asia; in Africa, peanut sauce can often be used. In West Africa, red palm oil is a fine source of fat and is doubly nutritious because it is so rich in carotene. Fish, eggs, milk or skimmed milk should be used whenever available and affordable. Breastfeeding should continue for as long as possible, but there will always be circumstances under which this ideal food source is not available or insufficient.

Nutritional adequacy, ready availability, and low costs are the prime considerations in basic fulfillment of requirements in a nutritionally marginal situation. If the infant is still on the breast between 6-12 months but with breast milk output declining and nutrient requirements increasing, then quantities sufficient for initial supplementation, for two meals daily, might consist of:

--100 g whole maize flour, millet flour or rice.
-- 30 g (dry) of legumes like beans, cowpeas, green gram, etc.
-- 30 g of dark green thin-leaf vegetables.

The mixture furnishes about 500 calories, 18g of protein and 2mg of carotene. Vegetables should be mashed or sieved, a little oil or fat added and made into a rather thick porridge to contain sufficient nutrients in a small volume. Mothers would be well advised to start gradually feeding mashed vegetables to infants at an early age, e.g., in the fourth month, so the baby can be initiated to the taste.

A child between 12-24 months should receive two or three times the amount of leaf vegetables for the 6-12 month old. Since it has teeth, a soft consistency is less relevant. The maize-peanut and maize-bean mixtures have proved successful in Africa, and the rice-green gram mixture has benefitted Indonesian children for many years now. If gari, cassava or sago are the staple foods, the addition of (dried) fish would be essential.

Figure 4. Selling African cabbage leaves (*Brassica carinata*) on a village market in the highlands of Kenya. Even those small quantities contribute a little cash.

Potential Drawbacks of Leaf Consumption

There are a few factors which require caution in the consumption of leaves. One is the potentially toxic factor of hydrocyanic acid. This acid is not rare, though it comes in variable quantities in otherwise edible leaves. It is, however, as highly volatile as it is poisonous, and evaporates at a low temperature. Therefore, any preparation which includes heating will render the leaves innocuous. A well-known example is cassava, both the tubers and the leaves. The high HCN content does not keep devotees of cassava leaves from consuming them, but they are well aware of how to prepare them.

A different and less important drawback is oxalic acid and the oxalates (oxalic acid salts) present in many leaves. *Amaranth* is one example, and many sourish leaves like purslane, *Celosia*, *Basella* and *Talinum* contain appreciable quantities. Oxalic acid is mildly toxic; its salts remove some of the calcium entering the body from food. In leaves of some taro species fine oxalate crystals, called raphides, are present. They cause itching under the cook's nails and a burning sensation on the tongue of consumers. Prolonged or repeated cooking after changing the wash-water, adding potash, consuming non-irritating species, or using young leaves only can alleviate this problem.

Exactly how many of the nutrients in the leaf pulp are absorbed with beneficial effects into the human body is not sufficiently known. To maximize absorption one should choose leaves that are neither too old and coarse nor too young and immature and add a little fat. Young children should be assisted by mashing or sieving the leaves before eating. Prolonged boiling may cause loss of certain nutrients, but some cooking to produce a soft or at least wilted texture is preferable to eating uncooked vegetables or fresh salads.

In conclusion, although there are a few drawbacks to the consumption of leaves, sufficient care in the preparation of leaves alleviates most of these problems. Their general availability and high nutritive value provide adequate reason to encourage increased consumption of leaves. Leaves alone will not provide the solution to the staggering problem of global malnutrition, but they can make a significant contribution.

[Adapted from *Tropical Leaf Vegetables in Human Nutrition*, Chapters 4 and 5, pp. 24-41 and 51-55, Communication 69, Department of Agricultural Research, Copyright© Koninklijk Instituut voor de Tropen, Amsterdam, 1977.]

Editorial Note: This article is addressed to nutritionists and does not deal in depth with peoples' tastes, and whether they want to consume leaves or leafy vegetables. Finding ways to prepare leafy foods that will overcome unfamiliarity and unpalatable taste is a challenge to ingenuity, and methods would vary by location.

Some Elements of a Child Nutrition Program

Margaret Cameron and Yngve Hofvander

[Some of the important elements in a program of child nutrition, if it is to be successful, include a body of accurate information on the food habits and related circumstances of the people affected, and a continuing effort to inculcate nutritional education. The advantages of nutrition rehabilitation units are described.]

Information Needs

Before a successful program can be started in a new area, a great deal of information must first be collected. Some of the information needs are the following.

Find out about the people. The first step is for program designers to get to know and understand how the people in the area to be served actually live and, at the same time, to gain their confidence and respect. The community worker should be consulted, and if he/she is new to an area should strive to become familiar with local traditional leaders and their pattern of authority, the social customs and cultural beliefs, the work people do, and their level of education. The worker also should try to discover what the people think are their most urgent priorities or needs. All this information must be conveyed to the national planning authorities.

Where there are no resident community workers, outside researchers will have to collect the information. Because of difficulties with dialects, an interpreter

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may be needed; but all personnel should learn a few words of greeting before any interviews begin. The interpreter must be a person who is acceptable to the community and its culture.

Information on the most relevant health problems is essential. This will give a clear idea of specific nutritional deficiencies and the most common infections or parasite infestations in the community. Any attempts to make changes must be built around the best of the traditional customs.

Find out about food. Every community has its traditional feeding patterns and beliefs about certain foods, some of which are favored and prestigious while others are taboo. Usually some reasoning lies behind these beliefs, and that should be ascertained. In addition to knowing what foods are used, information must be collected on the available kitchen utensils, storage methods, water sources, fuel and any difficulties in obtaining it, cooking methods, and meal distribution within the family.

Apart from observing what goes on in the households while endeavoring to know the people, a great deal can be learned from looking at the village gardens, the fruit trees, bushes or vines, and by frequent visits to the local market to see what items are stocked and what is bought, their unit costs, and the usual amounts purchased. Discussions with the people will help a worker to discover some of these facts and, at the same time, will establish a sympathetic contact between the worker and the new community.

Foods with high prestige are not always the most nutritious, but they may be made more valuable nutritionally and still keep their status by small modifications or additions. Finding the means by which this can best be achieved will depend on careful observation.

Find out about family economy. Proposals for improving the infant's intake of food can be made only after establishing where the food comes from. Advice depends on whether the household is dependent on a subsistence economy in which the food is grown at home, or whether it is all bought at a market. The quantities of food available and how much money is spent on it also must be known. In either case, expenditure is affected by market prices, which to a great extent influence the quantity of available food for any family. Giving advice on the budgeting of home-grown food supplies from one harvest to the next is more essential in the rural areas than how to budget money, which is more important for those who live in towns. Only by informal discussions and indirect, tactful questioning will it be possible to get some indication of how the family budgets are used. It is particularly important to find out if money is spent on special infant foods, what these are, and why they have been chosen. No nutrition education can begin unless this kind of information is known and taken into account.

Find out about environmental hygiene. Personnel must make a point of understanding the hygienic conditions in the households. If the general hygiene in the home is poor, a high rate of intestinal and other infections is to be expected. Conditions can be worse if methods of storing and handling food are also unsatisfactory. Clean food and clean utensils are essential for successful feeding, and of supreme importance if the infant is not being fed from the breast. The bottles, cups, spoons, or other utensils used for artificial or supplementary feeding, how they are cleaned and where they are stored, and actual methods of preparing the food should all be investigated. Personal hygiene also should be stressed in nutrition education.

Making the plan. A plan for a nutrition program should be based on all the information which has been collected. The program most likely to be successful is the simplest, and involves the least possible change in traditional ways. It needs to include the following:

what mixtures of food are best to recommend, and when they can and should be given;
where the mothers can be taught how to prepare them;
who will teach them;
how teaching can be followed up in the home;
where and how checks can be made on children's growth and development;
what records should be kept, and how this has been organized;
who will be responsible for assessing the success of the program.

The Education Component

The kinds of people working in nutrition education differ in each country. Some places have trained nutritionist-dietitians, with assistants, but in many countries they are few in number at present. Nurses, health visitors, home economists, community nurses, midwives, and auxiliaries are trained by the health or agriculture ministries. Local women or girls in their late teens have been taught to do simple teaching in their villages. Basic training is needed at all levels, and wherever possible this should be extended to short, but regular, refresher courses. Such courses encourage the staff and auxiliaries, bring them up-to-date, and coordinate teaching. The more they understand all aspects of the work, the more persuasive they can be in their dealings with mothers and children. With exchange and ideas through discussions, the staff becomes more flexible and better able to suggest alternative ideas to the women they go back to teach.

In an agricultural community, education should not be limited to mothers or grandmothers. Fathers, often farmers, should be encouraged to join in any teaching program. They may have more interest in their crops if they realize how important they are for their children and are shown how the yield may be increased for consumption, for preservation, or for marketing.

In urban areas, housing and cooking facilities may be extremely poor. The mothers may go out to work and the available market foods may be unfamiliar, and expensive. These problems form the basis for teaching the mothers at a time when they are free to join in some community group.

The success of teaching depends on the personality of the teacher, as well as on her training. She must be firm but sympathetic and have a sense of humor. She must be prepared, and take the time, for a chat with each mother so she can become familiar with individual problems.

The timing of any class should be convenient for the mothers and may coincide with clinic visits or some other community gathering. The setting for the class should be comfortable and relaxed, to encourage questions and discussion. Often a class can be held outdoors, sheltered from the strong sun and where everyone can hear and see what is being demonstrated. The group should be kept small. A series of short demonstrations for 10 to 12 mothers is much more satisfactory than a longer one for more people (Figures 1 and 2). There should only be a few points made in each lesson, and they should be simple and clear. They will be remembered more easily if they are related to something already familiar to the mothers.

The lesson should be short, because mothers with small children will have difficulty concentrating for long and may be some distance from home. Their interest should be attracted right from the beginning, perhaps by asking questions about their homes, their families, or their last visit. Whenever possible, one of the mothers should be asked to assist in the teaching. This may be particularly convincing to others if she herself has had a malnourished child who has improved on "village foods" only. Often such mothers are eager to teach others about what has helped her and her child.

Any demonstration should be in terms of foods and utensils with which the mothers are familiar, and which are within their means. Foods should be those they can produce on their farms or in their gardens. Better budgeting of food supplies should be taught to insure enough food from one harvest to the next. It should be pointed out that the temptation to sell the main crop of beans at favorable prices after harvest is not wise economically, if later in the year

Figure 1. Nutrition Education: Lesotho.

Figure 2. Nutrition education in Ethiopia. A mother helps to teach at a demonstration center.

some must be bought back at a higher price. Mothers in urban areas should be given guidance on how to budget their money and how best to spend what is available for food.

Traditional pots, clay or iron, should be used for cooking demonstrations on a stove or stones with whatever fuel is normally used. Stainless-steel pots or sophisticated stoves are unrelated to the mothers' home circumstances. Families and communities should be encouraged to build on and extend the best features of their own way of life.

If diarrheal diseases are common, teaching should emphasize the hygienic aspects of handling food. Care of feeding utensils, storage of raw, prepared, or preserved foods, and the control of animals that might wander into the house must be included. If a vitamin deficiency is common, stress should be given to using foods that contain it.

In many places, supplementary foods are distributed to mothers and preschool children. The distribution center usually is a clinic, which should use the foods as part of the education program. Mothers should be taught why and how to use the rations, particularly if some of the ingredients are unfamiliar. Such teaching is even more effective if the mothers can taste the cooked product at the end of the demonstration.

Results of teaching can be tested by inviting a mother to repeat a demonstration for others at a later session. Follow-up teaching can be done informally during home visits as part of the preventive plan. Education need not always be in groups; it can be conducted informally with an individual at home, in or out of a clinic, or at some other meeting place. Examples set by auxiliary or other health workers can themselves be a continuation of teaching.

Teaching aids. The choice of teaching aids should be highly selective; their use is primarily to reinforce the points being taught. Posters are not helpful if they are used only as decorations on clinic walls. To be really effective, they must be designed with great care, using symbols that can be part of a lesson and cannot be misinterpreted in a specific community. One really good poster can be a link that connects the teaching done in all the clinics. The size, color, and contrast of the pictures must have a direct connection with the local situation and available foods. Good pictures or photographs may be understood more easily than line drawings, and they can be used if it is not practicable to have real food at the lessons. Printed materials obviously are of use only if they can be read and understood.

Flannel boards (bulletin boards covered with flannel on which felt figures and letters can be stuck) can be successful because mothers and older children can participate in using them. Films and film strips are helpful if the audience is accustomed to mechanical devices, but too often attention to the lesson is distracted by the movement and color.

Whatever the aid used, it must be a specific part of the lesson and be included in any discussions that follow. At each class mothers should be reminded of what was taught at previous sessions, and any education program should be followed up in order to judge its success. If results are disappointing, the general approach to the mothers and the teaching program should be reconsidered and replanned.

What to teach: for the infant. Traditionally and instinctively the majority of infants are fed breast milk on demand for the first few months of life. There are very few reasons why a baby should not be breast-fed and, in many circumstances, survival depends on it. Encouraging the continuation of breast-feeding for at least the first year of life is recommended strongly, particularly if the infant is liable to be weaned, as so often happens, onto a protein-poor diet. Breast-feeding can be continued on demand when the mother works in the fields, at market, or even at some light industry in the local village community, but it is not as easy to do in the towns if the mother is working regular hours, especially if no day-care center is available. Under these circumstances, the infant probably will be left at home with an older sister or grandmother. Breast-feeding should be encouraged for the morning and evening meals but, while the mother is away, particular care must be taken to feed the infant suitable meals with adequate fluids, using clean, safe water.

At the age of about four to six months, the amount of available breast milk cannot by itself supply all the energy the growing infant needs. As a consequence, supplementary nutrition must be provided. (Discussed in other articles).

The importance of hygiene cannot be overstressed. Food mixtures cooked into a pap or porridge and fed with a spoon from a clean cup or bowl are preferable to those given from a bottle, which is difficult to keep clean. Another dangerous, unhygienic method is feeding from the mother's hand, which should be vigorously discouraged. A traditional way to prepare food for infants is for an adult to chew it first. The practice may help to give the baby a softer carbohydrate food, but this small advantage must be weighed against the dangers of transmitting infections to the infant and underfeeding it.

Fats, oils, or sugar can add new flavors to a meal; they also reduce bulk. Improving palatability and increasing nutritional content per unit of food weight can result in better nourished infants.

For the young child. By tradition, the young child shares the adult family diet after breast-feeding ceases. By then he has teeth and is more than ready to chew food. The beneficial nutrient effects of adding vegetables or oil to a mix are great. [See also the two preceding articles.]

The number of times the child eats each day and his share of the family meal depends on when and how it is distributed in the home. Sometimes he eats from his own bowl or plate, but he may have to share a larger dish with older family members. In most places, the main part of the meal is provided by the staple food. This is accompanied by a side dish, such as a stew, sauce, or soup, which usually contains most of the meal's protein because its ingredients include meat, fish, or beans. Therefore, it is important that the growing child gets a fair share, for a child's requirement for good protein per kilo body weight is higher than that of the parents. Unless special care is taken, the child's portion of fish or meat, eggs, or beans may be very small. In many societies, it is traditional for the father and the older male members of the family to eat first and take the best, usually the protein-rich parts of the meal; the women and children use what is left to flavor the bulkier staple food. A child between two and three years of age can be at a further disadvantage, because supplies of breast milk might have ceased, so intake of food depends entirely on what the mother thinks he should have.

The number of meals available for a young child each day is a prime concern. If the adults in a household do not eat three meals a day, provision should be made for the child to eat frequently. He may be given snacks of food left from the previous meal and carefully stored, some fruit, a beancake, or some kind of drink that provides energy and protein. A guide to the adequacy of the food intake will be the child's record of regular weight-gain and general alertness.

Between the ages of one and two, a child may not be able to manage the complete adult diet, and mixtures or meals suitable in both energy and protein value, as well as in consistency and bulk, can be provided without excessive extra preparation. These meals can be made from ingredients that are available locally, are inexpensive, and likely to be used in most households as a family food. The preparation methods are traditional in the areas or regions in which the foods grow. At this age, young children often contract measles, whooping cough, or some other infectious disease. If their diet has been adequate, their symptoms usually are less severe than those of underfed children. However, even if sick, the child needs nourishment, and a troublesome cough or a sore mouth makes it necessary to alter the diet. Dry, crumbly foods or hot, spicy meals should be replaced with blander foods. Appetite, too, is affected by infection, and a sick child can be encouraged to eat by offering foods other than his usual intake.

Nutrition Rehabilitation Units

In addition to the strictly preventative components of a child nutrition program, there must be curative components. These will include hospitals and clinics for the seriously sick, but they can also include units for supervised care of children by their mothers when they are less seriously ill. Such nutrition rehabilitation units supply instruction to mothers and the foods needed for a proper diet for children suffering from nutritional deficiency who need special attention but not hospitalization. Many such units have been started in developing countries in the last few years.

The basic aims of these units are to achieve nutritional rehabilitation for the children and, at the same time, to educate the parents, especially the mothers, in the feeding and care of children in an improved home environment. A specially trained auxiliary is likely to be in charge. She should be capable of giving health education talks to show how nutritious meals can be prepared from locally available supplies, how much the child should eat, and how often. A mother is always responsible for feeding her child at these units; some of the time she will be given direct supervision while preparing the meals. This is part of her training, and the task is to persuade her that similar meals can be prepared easily at home, at low cost, and at the same time as the "family pot." Primarily, she must be made aware that good meals are the only treatment her child needs.

The recommended mixes the mothers will be asked to prepare and feed their children should be based on their own local foods, available within their budget, and related to any specific nutritional problem in each area. Nutritional recipes should be formulated by the auxiliaries, and it is recommended that they be tried on a few children in one or two meals daily. A great deal can be learned from such trials--for instance, how the children like it; whether the stools change in smell, frequency, or consistency, which the mothers may notice and complain about; how much food can be given at one time; how long it should be stored before it spoils; and so on. The children who are given the food should be supervised closely during the week or weeks it is being tested, so other mothers can be informed about the children's reaction to the new mixtures. The basic food in any mix should be a local cereal supplemented with one of the other foods easily obtainable in adequate quantities. If other supplementary foods are available through a clinic or distribution center, mothers should be shown how to use these to the best advantage, but it is not advisable to let them become too dependent on expensive imported supplies.

If mothers of infants or young children who already have recovered through nutritional treatment only can assist or participate in the talks and demonstrations, an excellent example is set for the mothers.

Day centers that include a residence are the best settings for such a plan. The resident mothers can participate either at the centers or in the nearby outpatient facilities, for their teaching is often more effective and persuasive than that of nurses or other "white-coat" staff members. Fathers also should be encouraged to visit and join in activities at the residential center.

It is hoped that a mother who is discharged with her recovered child will go back to her village convinced of the value of the feeding pattern she adopted in the center and that her knowledge of improved feeding will be a good influence in her own community. Sometimes it is useful to award such a mother a diploma for what she learned during the course of her child's rehabilitation and applied afterward at home. The diploma might have photographs of the child and mother on admission and again at discharge; such "before and after" evidence can be impressive.

Rehabilitation units usually are located close to a hospital or a health center. The buildings are simple. Some are mud houses, but with various improvements that are within the means of most local families. Some have such amenities as a raised fireplace, a soak pit, latrine, or compost heap. Some have a vegetable garden or a simple arrangement for raising poultry and producing eggs for the center. It is worth noting that the expense of running a nutrition rehabilitation unit is comparatively small; the cost per child per day is only a fraction of the cost for a patient in hospital.

[Extracted from Chapters 8 and 13 of Manual on Feeding Infants and Young Children, 2nd edition, pp. 71-84 and 113-118. Published by the Protein-Caloric Advisory Group of the United Nations System, New York, 1976.]

Note: This manual is available in English, Spanish and French editions, and can be obtained from local offices of WHO, FAO or UNICEF, or from FAO Headquarters, Via delle Terme di Caracalla, Roma, Italy. A 1981 edition of the manual is currently being prepared.

Community Awareness: A Strategy for Attacking the Problem of Child Nutrition

Save the Children Federation, Inc.

[Programs to combat rural child malnutrition can only succeed where community members are ready to take action on a sustained basis themselves, and believe this is possible and potentially effective. Actions by outsiders to the community, however well intended or enlightened, cannot substitute for this community endeavor.]

The presence of malnutrition and its inhibiting effects on human growth and performance point to the need for concerted efforts towards the prevention and management of this problem. It has become increasingly evident that the active involvement of communities, their perception of the problem and their subsequent participation in its solution, are critical to success in overcoming malnutrition.

Save the Children Federation (SCF), a non-profit voluntary organization working overseas on community development, has been concerned by the lack of community involvement in the identification of child nutrition and health problems and in the planning and implementation of solutions. Villagers are individually aware of nutrition problems; but they are neither discussed nor acted upon by the community as a whole. Even the best community workers, whether foreign personnel or local nationals, have difficulty discussing health and nutrition with villagers. With this in mind, the following strategy has been developed to assist field workers in leading communities and community leaders into confronting and trying to deal with health and nutrition problems and their solutions.

Composed by the Health/Nutrition
Staff of Save the Children Federation,
Westport, Connecticut, with Tina
Sanghvi, Consultant.

This community awareness strategy was originally developed in Pespire, Honduras. It was later adapted and field tested by SCF in villages in Bangladesh and Indonesia. Results of the approach have been encouraging, although not conclusive, and the program outlined here does not represent the only approach to creating community awareness of local malnutrition.

The purpose of an "awareness program" is to make a community so concerned about malnutrition that they will want to organize a good program to fight it. Why does this usually not happen? Villager responses to queries about the problem are often like this: "I know that many children in our village are sick, too thin, or don't get enough food. But what can we do? It is because they are too poor;" or "It has always been like this." Yet, nutrition experts know that children can be saved from dying of malnutrition without a lot of money, and that poor people can help themselves. Perhaps the following are reasons for such answers:

The community may not really know how serious the problem is. They have become accustomed to seeing a few thin or swollen children and have seen them die young, and they may understand the causes in a very general way. But they do not realize that many more children are less visibly affected, and that the malnourished children who survive cannot work as hard or earn as well when they become adults, that their intellectual capacity can be impaired and that they become ill more easily.

In other cases the community may realize that malnutrition is a serious problem and would like to help, but the people think that they are unable to do anything because it will take too much money, special foods or medicines, or because it is "God's will" and cannot be changed. However, the causes of malnutrition can frequently be attacked and substantially reduced without spending a lot of money. Mother's milk is the best food for young infants, and should be continued as long as possible. Much disease can be prevented by boiling all drinking water, by scrubbing hands and raw foods before feeding them to young children, and by safe disposal of excrement. Immunizations are also important in preventing disease.

If a community is not organized to join together and help fight malnutrition, activities such as improved water supply, latrines, and the training of community health workers cannot be well run. In many villages there are attitudes like those reflected in the following statements: "If this child is sick and malnourished, it is the family's job to do something about it. Why should I be concerned?" or "His mother is not a good woman, his father is an alcoholic or doesn't work." In order to effectively combat malnutrition, the community must recognize the condition as being everyone's problem, not just that of a few families with sick or very thin or swollen children.

For each obviously malnourished or ill child, there are at least ten others who are in danger of becoming very sick even though they appear to be healthy now. Further, any community that has malnourished children will also have malnourished adults. It is only because children grow so rapidly and food deficiency shows up so quickly that we often forget the adults whose energy is drained by inadequate nutrition, prohibiting effective work and causing rapid fatigue. Statistics show that a malnourished person dies younger than a well-nourished person. People live much longer in communities that have good drinking water, basic health services, safe methods for disposing of excreta and where the children are fed mother's milk for an adequate length of time. So malnutrition should be a concern for everyone, even those whose families appear healthy now. They should take the responsibility to fight it together with other members of the community. A good program requires a joint effort.

In some villages, there may be food "giveaway" programs underway. Unfortunately, these programs frequently have less beneficial effect in preventing childhood deaths and severe malnutrition than is expected. They can create dependencies, and postpone finding solutions to the real problems causing malnutrition. Further, the most needy and sick children often do not come for the food when it is available, and even if they do the food may be shared by all family members at home rather than kept for children in greatest need. In other cases, the distributed food replaces, rather than supplements, the food that the child had previously been given at home. Also children who are always sick with parasites, fevers, or frequent loose stools lack the appetite to eat as much as they should. Food giveaway programs may be effective short-term answers, but by themselves are not enough; only when combined with good child care practices and good sanitation in the home can they effectively combat malnutrition.

People must help themselves in giving their children proper food from whatever is prepared for the rest of the family, and extend breastfeeding for the infants. They must make efforts to construct and--most important--to maintain and use latrines, sewers and a safe supply of drinking water. These things cannot be done on any sustained basis by outsiders to a community. Outsiders can, however, facilitate the awareness of need, and help initiate remedial actions. The orientation program that follows is intended to help a community to understand this, and to focus on creating programs which really work in helping malnourished children and mothers to become strong and healthy.

Method

The facilitator. The heart of the proposed strategy for stimulating community awareness of child nutrition problems is a kind of community worker we will call a "facilitator." Such a person could be either a foreigner or a national employee of a private voluntary organization such as SCF, or employed by the national government; the discussion here assumes the former situation. The facilitator's function presumably should be combined with other work which would bring the worker into the rural community. The facilitator must have sufficient knowledge about nutrition and health subjects to guide villagers, but need not be a high-level professional. He or she must also be skilled in communications, in approaching villagers in ways appropriate to them and gaining their confidence, and in stimulating actions that will not be dependent on the facilitator's continuing presence but will endure after his or her departure.

The facilitator's role initially is to encourage community groups to talk about malnutrition. This role calls for a lot of imagination and flexibility, and should not be performed in any rigidly defined way. The facilitator can assemble people and talk to them about the prevalence of malnutrition and what can be done about it, but this will hardly suffice. Villagers, like students in school, may listen quietly and nod their heads in agreement, but with less than full comprehension and even less feeling of participation; respectful manners are of less value than lively, perhaps impolite concern. Facilitators must find what people are concerned about, and build on that into the subject of children and their condition. People should be encouraged to relate their children's experiences; in time, villagers should begin answering each others' questions, with the facilitator amplifying or supplying technical points. The facilitator can highlight the important conclusions after they emerge.

Group discussions will become more meaningful for eliciting community action than talks with individuals or families. Facilitators should develop various ways of leading such community groups, e.g., sitting down with them, not standing before them like teachers with a class. The objective is not so much to teach nutrition as to get villagers to teach themselves, to draw out from them their experiences for group examination. Rather than listing the topics that need to be covered, let us illustrate how one might approach the subject of germs.

Germs in the surroundings. Where do germs live? They live in the air breathed out by sick people; in unclean, unboiled water; in the dust and dirt where people defecate and where garbage is thrown; in houses where animals live too near the people and where there is not enough ventilation; in raw, unwashed foods; on unwashed hands and feet; and on flies. At this point in the discussion a supportive illustration would be useful. The following simplified story could serve as a basis with variations added to make it more relevant to the local conditions.

"Listen to what happened to little Maria. Her mother already had five children when she became pregnant with Maria. Her youngest child was then only eight months old.

"Her mother felt constantly tired and could not care for the other children. She didn't eat enough because after her husband and other children were fed, there was not much left for her. The neighbor who was also pregnant went to the feeding program center and received extra food, but Maria's mother who needed it more because she was so thin and weak didn't have enough time to go there and wait.

"Two months before Maria was born, the youngest child came down with a high fever and suddenly died. Maria was born thin and pale and her mother had a low fever for many days afterwards. Her husband had to take her to the doctor in the town several miles away and buy expensive medicine. When she felt better, she was able to feed Maria breast milk.

"Maria became healthier and fatter--she was putting on weight, getting heavier and seemed to be growing well. Then at about four or five months her mother gradually stopped breast feeding Maria and started giving her cow's milk with sugar in it.

"Maria did not drink enough of this and in one month started to look thinner and became pale. One day her mother went to the market on her weekly visit. Before leaving she told her five children that she had prepared some food for them that she had left on the mat. She told them that she might be late and to go ahead and eat their food. It was a very hot day and flies which had spent the day walking around on the rubbish heap flew inside and rested on the food. Their feet were sticky and dirty, and as they hopped over the food they left tiny germs which the children could not see but which cause disease. The children came to eat their meal. They were very hungry and ate up all the food which was then covered with tiny germs. Maria, a weak and thin little girl, stuck her fingers in the food and sucked at them happily. Her older brother gave her some water from a jar filled from the nearby well.

"During the night, Maria woke up and began to cry. She seemed to have pain in her stomach and her stool was very loose. She defecated several times during the night and in the morning was very miserable. Because her mother believed that children become sicker if they drink or eat during an illness, she starved Maria. For the next day or two the little girl, already thin and frail, looked sad and developed sunken eyes; her skin became dry, loose and creased like paper.

"But they did not take her to the doctor until it was almost too late because the town was far away and the father was busy harvesting. Besides, they did not have enough money until the harvest was well underway."

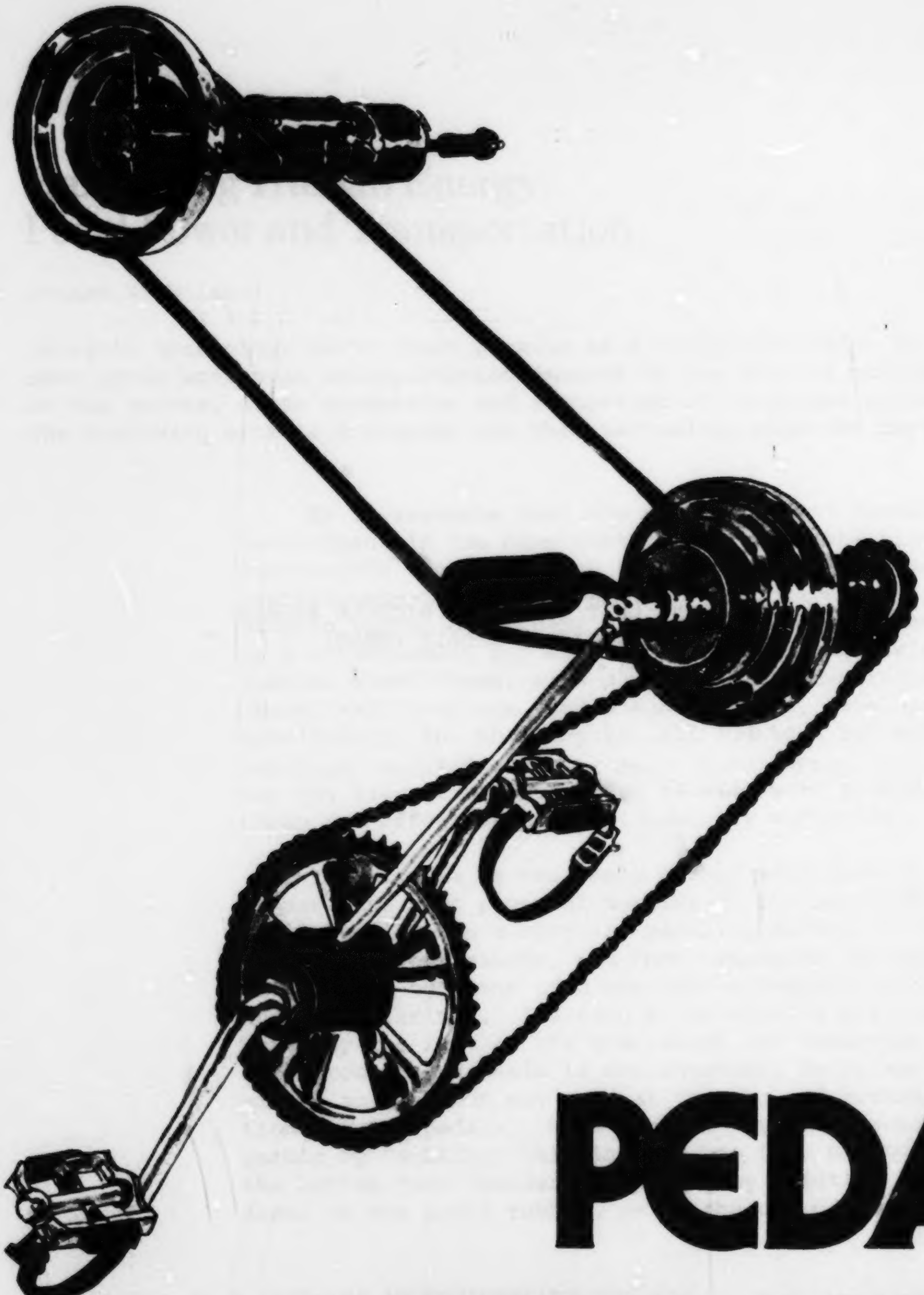
Follow-up. After this or a similar simplified story, the facilitator should elicit responses from the villagers through questions like: What things made Maria come so close to dying? The facilitators should probe for responses like: her mother was weakened by having several children too close together, so that Maria was born without sufficient strength to grow and fight germs; she stopped breast-feeding Maria too early; and the cow's milk was not boiled to kill the germs in it before giving it to the child.

Further responses might include: the children defecated near the house and there was garbage on the ground nearby so children playing barefoot would pick up germs. These practices also attracted flies which carried germs to areas near the house; the water for drinking was not boiled; the food was left uncovered so flies could walk on it; no water was given to Maria when she was losing water through diarrhea, so she became dehydrated; and they did not give her medicine early enough to stop the sickness from almost killing her.

After identifying the problems, throw out a question that would elicit potential solutions like: What could the family have done? The facilitator should then probe for responses like: more space between children; continue mother's milk for up to a year or more; give cow's milk and other foods after five or six months; boil water and milk before drinking; keep foods covered from flies; use latrines; keep the rubbish heap covered with earth and away from the house; give food and water to children during sickness; and give the sick child medicine as soon as he/she gets sick.

At this point, the link between the community and the problem of malnutrition might be made. In order to do this the facilitator might ask a question like: What does the community need to do? Probing for responses like these would be beneficial. The community should: bring medical services to the village (some members can be trained in basic health care and can also help educate the mothers in proper child care); build latrines; provide safe drinking water; provide safe methods of garbage disposal; make sure that the really needy families can get food easily, if there is a feeding program in the village.

[Adapted from "God's Will or a Community Problem? A Community Awareness Strategy for Understanding the Problem of Malnutrition." Unpublished manuscript, 1980.]



PEDAL POWER

POWER UNIT DRIVEN BY BICYCLE PEDALS.
(ILLUSTRATION: RODALE PRESS)

Harnessing Human Energy: Pedal Power and Transportation

Stuart S. Wilson

[Bicycle technology shows great promise as a reasonable means to help meet goods and human transportation demands in the face of rising petroleum prices, urban congestion and a shortage of motorized vehicles. The following article discusses how this technology might be improved.]

It is arguable that the most important technical development in the nineteenth century was the bicycle. Pre-bicycle transportation technology was heavy and inefficient--typically the steam locomotive--but post-bicycle technology became lightweight and efficient, both structurally and mechanically. The lightweight tubular steel frame, wire-spoked wheel, bush roller chain, ball bearings, and pneumatic tire, developed specifically for the bicycle, all led to a triumph of matching machinery to the human body, which contains why the bicycle has succeeded so widely in providing cheap and effective personal mobility worldwide.

The bicycle is extremely energy efficient in that it uses the most powerful muscles in the body--the thigh muscles--in a circular pedaling motion, 60-80 revolutions per minute, and then transmits the power efficiently by means of a sprocket-and-chain mechanism and ball bearings. The torque, or turning effort, exerted by the feet on the crankshaft and therefore on the sprocket and chain is not constant, being appreciably smaller but not zero at the top and bottom positions of the pedals. This minimum torque is achieved partly by "ankling" (tilting the top foot upwards and the bottom foot downwards), partly by friction of the shoes on the pedal rubber, or by the use of toe clips.

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The minimum torque varies with individuals but is of the order of one fifth of the maximum. On a bicycle this variation has little effect because of the inertia of the rider and machine; but if we consider driving a stationary machine, for example a pump or a corn grinder, then the motion becomes jerky and it is desirable to even it out, either by incorporation of a flywheel or by other means, such as the use of an elliptical sprocket, which in effect varies the gear ratio twice during each revolution of the crank.

How much power can we expect to be able to supply by pedaling? Tests done under laboratory conditions do not relate too well to experience on the road; but tests at Oxford on a bicycle with a built-in dynamometer confirm that 1/10 horsepower or 75 watts is a reasonable figure for the sustained output of an average rider at a road speed of 12 mph. On the other hand, 1/4 horsepower, or nearly 200 watts, is produced at 18 mph, which many riders can achieve at least for a limited time; and up to 1 horsepower or 750 watts is possible for a second or so.

These figures reveal a remarkable overload capacity of the human body--the ability to exert 10 times our normal output when required. The question is how to apply this muscle power to useful ends. In addition to personal transport, as with the usual bicycle, how can we develop the means of helping people to help themselves in other ways by their own efforts, without depending on expensive petroleum?

Figure 1. Bicycles remain a popular transportation vehicle in many countries.

Goods Transportation

Let us consider extension of bicycle technology to goods transport. The carrier bicycle with a large basket over the front or back wheel is effective for loads of up to 100 lb. or so (Figure 1). Beyond that, however, three wheels are better than two (Figure 2). Three-wheeled vehicles have been in use since the nineteenth century, but have evolved only slightly. A recent attempt to rethink the design is shown in Figure 3. It was designed by the author and built at Oxford with support from Oxfam. Named the "Oxtrike," it is designed as a basic chassis with a choice of bodies to carry a variety of goods or people up to a payload of 330 lbs. or 150 kg [see also Development Digest, October 1978, p. 80]. It incorporates a number of novel features in order to overcome some of the limitations experienced with existing designs of cycle rickshaw (pedicab, becak, or trisha) in current use in India, China, Indonesia, and Southeast Asia. Although a variety of designs have evolved in these different locations, there is little evidence of radical redesign in order to improve performance.

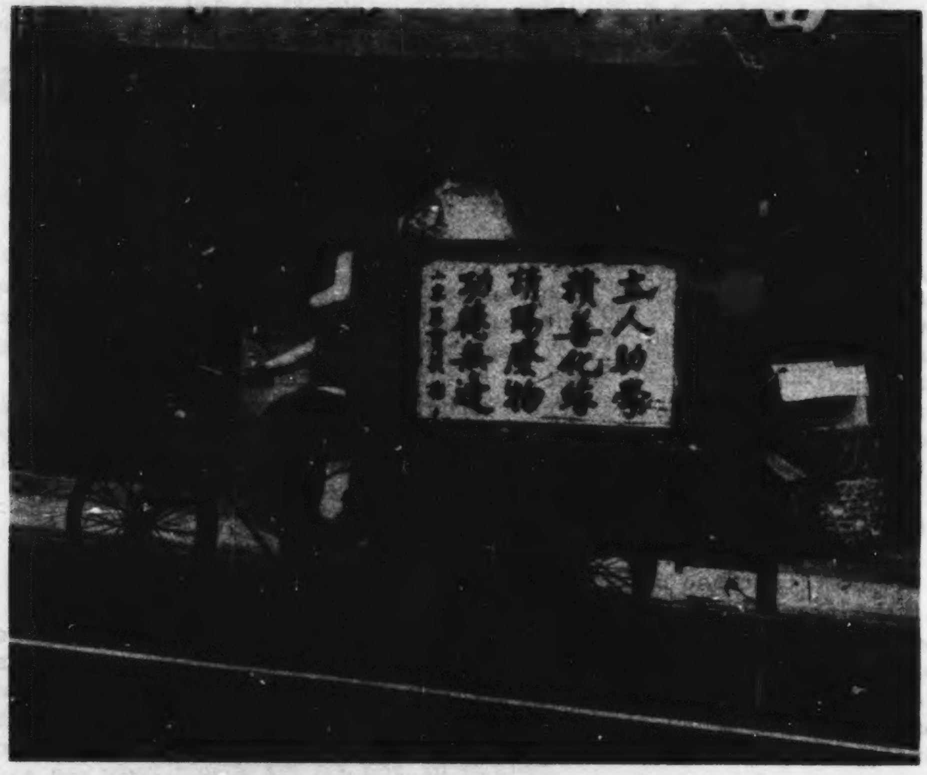

Figure 2. Tricycle used for transportation of goods in Taiwan.

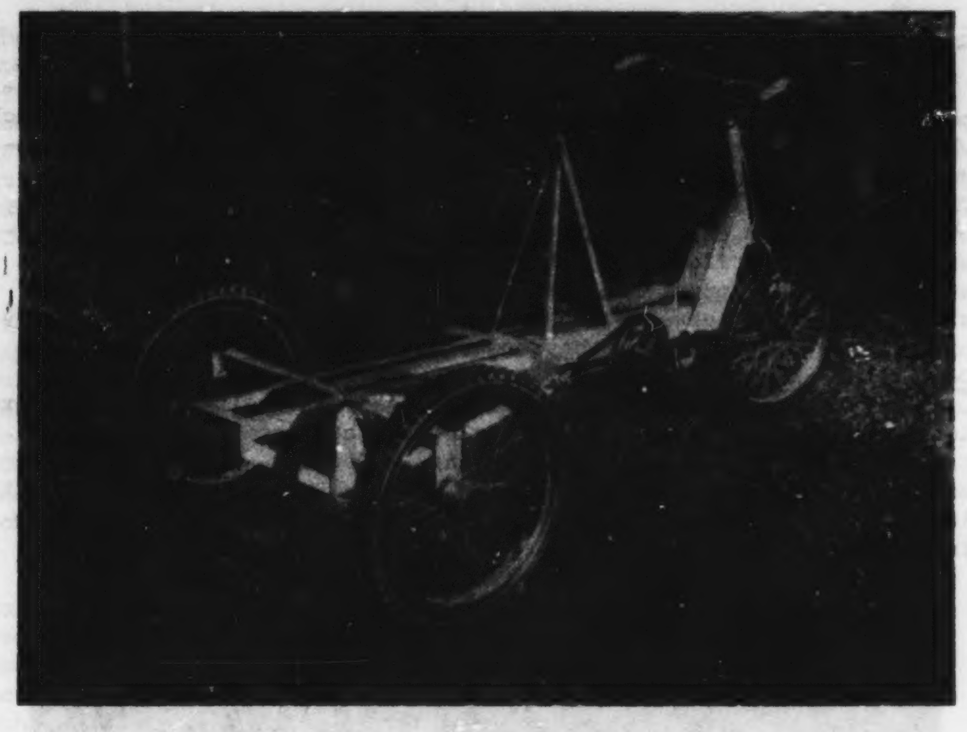

Figure 3. Oxtrike chassis.

The main defects of existing designs include the use of only a single gear ratio which is often too high, so that starting on the level or climbing a gradient imposes a severe strain on the driver; usually only one wheel is driven, while braking also is confined to one wheel--a dangerous defect. The use of standard bicycle parts often results in insufficient strength for the far greater loads imposed, leading to the collapse of wheels or forks unless specially strengthened. The frame itself, of tubular construction on bicycle lines, is a less than optimum design with regard to its strength-to-weight ratio.

Despite these defects, various types of tricycle have established themselves widely in Asia, though not in Africa or Latin America, although they are fighting a losing battle in some of the bigger cities such as Singapore and Jakarta. Some authorities wish to banish them on the grounds of lack of safety, causing congestion, and lack of a modern image. To abolish such a useful, low-cost, low energy, low-noise, and low-pollution vehicle would deprive the poor and middle classes of a most effective means of transport, and cause unemployment among drivers and associated trades.

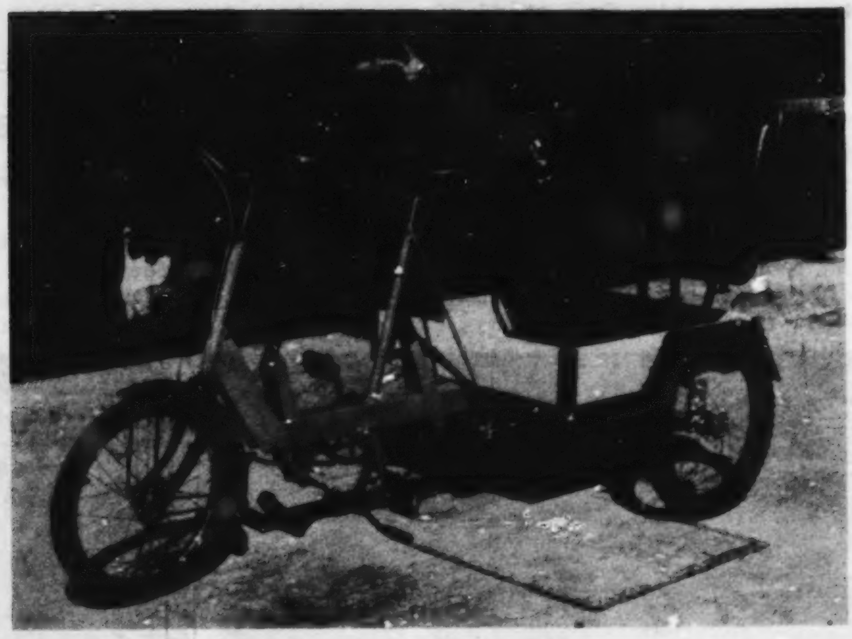

Figure 4. Oxtrike with temporary seat.

Since the tricycle holds exciting promise for both developing and developed countries alike, it seemed worthwhile to rethink the design with a view to maintaining or extending tricycle use. The Oxtrike overcomes five of the major problems in standard tricycle design:

1. Stronger wheels with smaller diameter have replaced the larger standard types. In addition to strengthening the vehicle, this change provides the added advantage of lowering the center of gravity and thereby increasing stability.

2. A three-speed gear box has been incorporated into the transmission system, improving the driver's ability to start with a heavy load and to climb at least a slight gradient. This greatly improves the vehicle's range and mobility.

3. A more extensive braking system has been installed with a hand brake for the front wheel, pedal brakes for the rear wheels and even a parking brake for use when the trike is not in motion.

4. Construction from standard square steel tubing and other materials not requiring special treatment makes Oxtrike manufacture far less complicated. This enables fabrication of the trike by local small-scale industries.

5. The variety of bodywork types available in the Oxtrike allow for numerous uses of the vehicle. A seat for two passengers (see Figure 4), a box for goods, a hopper with sloping ends for loose material like sand, or even a 40-gallon drum to carry liquids are added features from which the driver may choose.

[Extracted from Chapter 2 of
Pedal Power, James C. McCullagh,
ed., pp. 37-56, Copyright ©
Rodale Press, Inc., Emmaus,
Pennsylvania, 1977.]

Note: This publication is available on request from VITA, 3706 Rhode Island Avenue, Mt. Rainier, Maryland, 20822 U.S.A.

Harnessing Human Energy: Stationary Pedal Power

Michael R. Whiteman

[Potential uses of pedal power extend beyond the transportation methods described in the preceding article. This article discusses and illustrates some non-transportation pedal technologies and how they might be applied.]

With present fossil fuel costs and energy availability problems in both the developed and developing worlds, other energy sources must be considered and tested. One such source is as old as mankind itself; human energy as expressed through pedaling. Human energy can be harnessed through pedal power for tasks such as shelling maize (See Figure 1), operating a winch (See Figures 2 and 3) as well as a variety of other common tasks that generally require either electric power or a gasoline motor. Pedal power can be mobilized with an apparatus connected to a bicycle, as shown by the arrangement in Figure 4 which generates electricity. The pedal apparatus can also be built into the particular machine that it powers, which limits it to only one function; or it can be built as an independent apparatus and attached to many different devices. Such an independent unit might be likened to a power drill with many attachments, e.g., a screwdriver attachment, a sanding attachment, a grinding attachment, a polishing attachment in addition to drill bits.

Figure 5 shows an example of such an independent unit. Called a "primemover," it uses the basic bicycle design, but the chain driven by the pedals powers a pulley wheel instead of bicycle wheels. The

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This article was composed by Mr. Whiteman, Associate Editor of Development Digest, with materials from Pedal Power.

Figure 1. Pedal power providing energy to a corn sheller.

Figure 2. Close-up of brake handle and metal extension that wedges against the teeth of the sprocket to brake the spool.

Figure 3. The winch is a two-man operation.

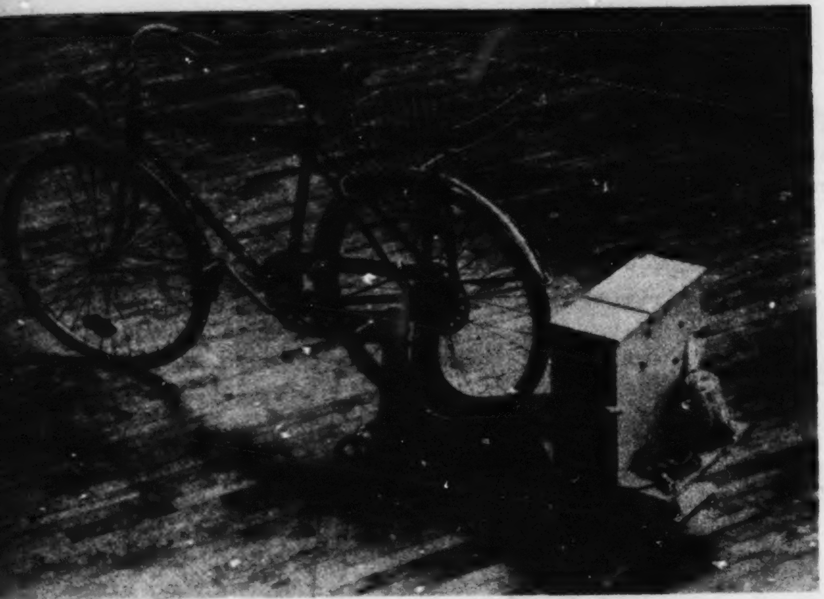


Figure 4. The Bik-O-Generator, manufactured by Homestead industries, will power a grain mill or generate electricity. A pulley attached to a power takeoff wheel could be attached to many other belt-powered tools as well.

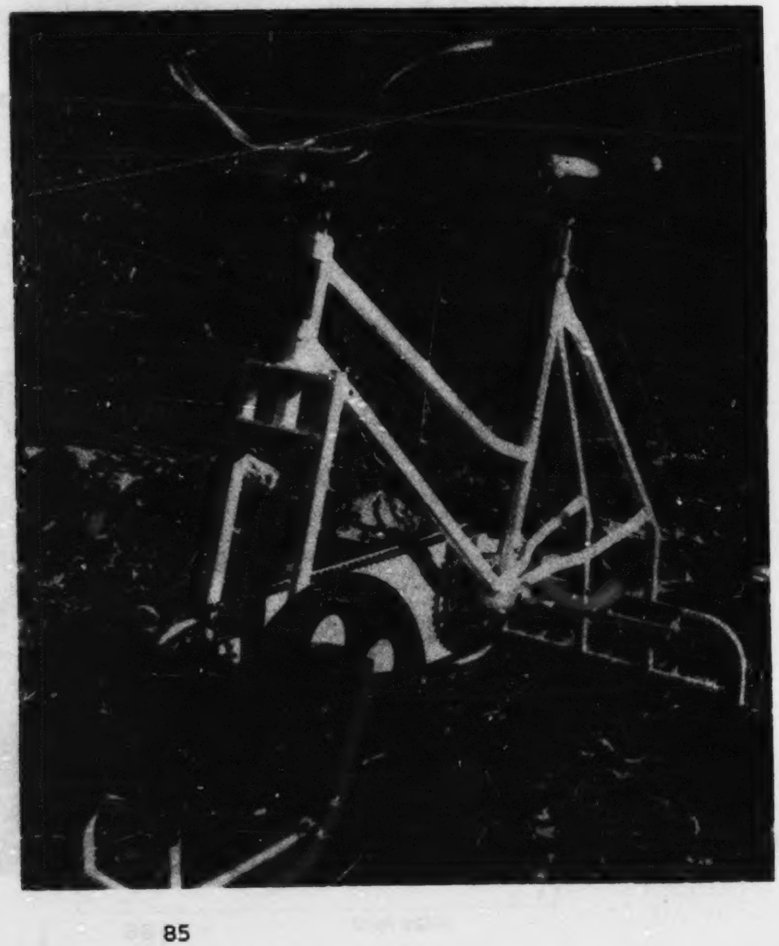


Figure 5. Pedal-driven primemover.

pulley is attached to one end of the drive shaft, and a flywheel is attached to the other (See Figure 6). This flywheel, in the weight range of 25-30 pounds, provides sufficient inertia to carry the mechanical operation through high speed torque requirements and thereby evens out the inconsistency of pedaling.

The primemover can be attached to any pulley-driven apparatus by using a transmission belt. By varying the sizes of the pulley wheel on the driveshaft and that on the driven machinery, a range of different speeds can be obtained which greatly increases the applicability and versatility of the primemover as a power source.

The primemover could be constructed from a standard bicycle frame. The one pictured in Figure 5 was made from an AMF "Whitely" exercise cycle. The bicycle wheels must be removed and extensions must be added at the base to stabilize the frame as is shown in both Figures 5 and 6. The driveshaft can be constructed with varying sized sprockets attached to produce the desired output speeds and gear ratios. The flywheel can be constructed by filling a cast-iron sheave with concrete to obtain the desired weight. Appropriate transmission pulleys are available in most hardware stores in various sizes.

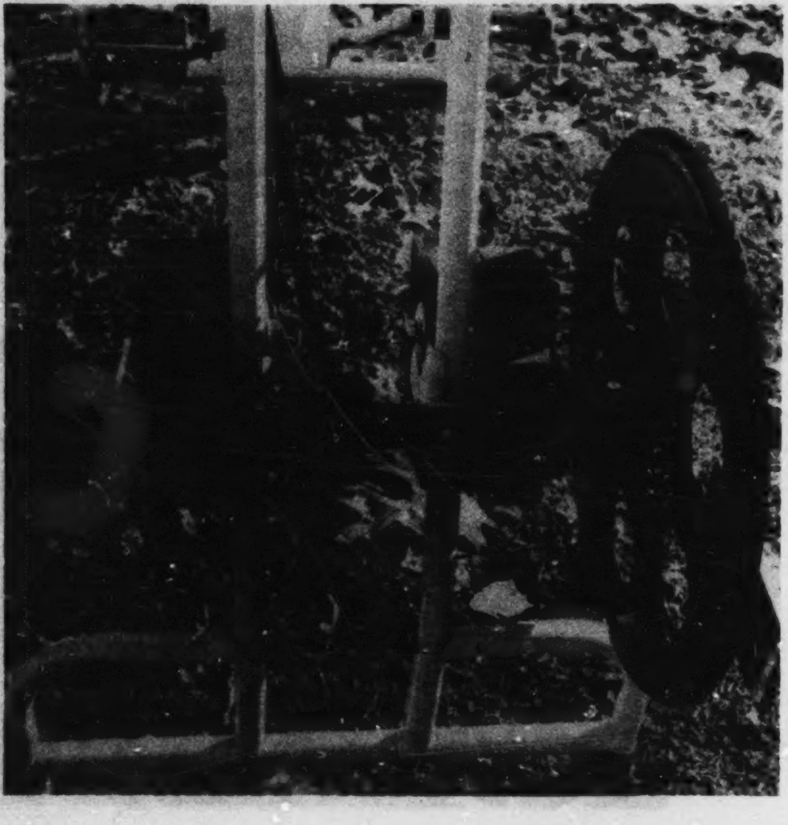


Figure 6. Close-up of drive assembly and flywheel from the primemover of Figure 5. Pulley wheel is on the left, flywheel on the right.

What can the primemover do? It can be attached to saws, pumps, churns, electrical generators, hydraulic units, and lathes (see Figure 7) just to list a few. The possibilities for the primemover are basically limited only by the extent of the user's imagination.

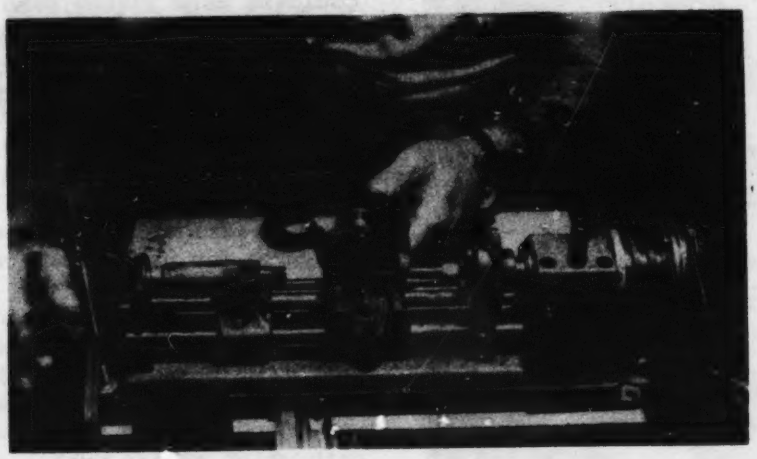
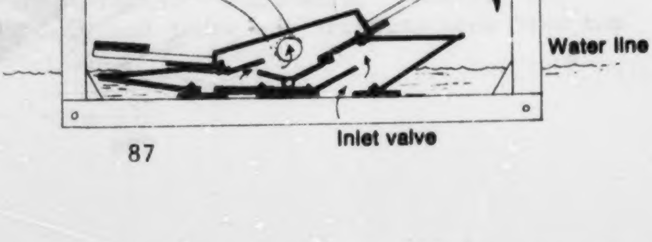


Figure 7. A lathe, one of many machines that could be driven by pedal power.

Another major area of need that can be addressed by stationary pedal power is water pumps. In regions where there is little petroleum available for deisel or gasoline-powered pumps, or where the costs for such pumps and fuel are prohibitive, human power can be substituted. A foot-powered pump developed by engineers at the International Rice Research Institute in the Philippines can lift large quantities of water several feet using only moderate amounts of labor. The operator simply stands on two foot rests at either end of the pump and rocks back and forth. That effort compresses a diaphragm which forces water from the outlet valve into the field being irrigated. By operating the pump in a rhythmic manner, a continuous flow of water is pumped (see Figures 8 and 9).

Figure 8. Schematic drawing of a bellows pump.



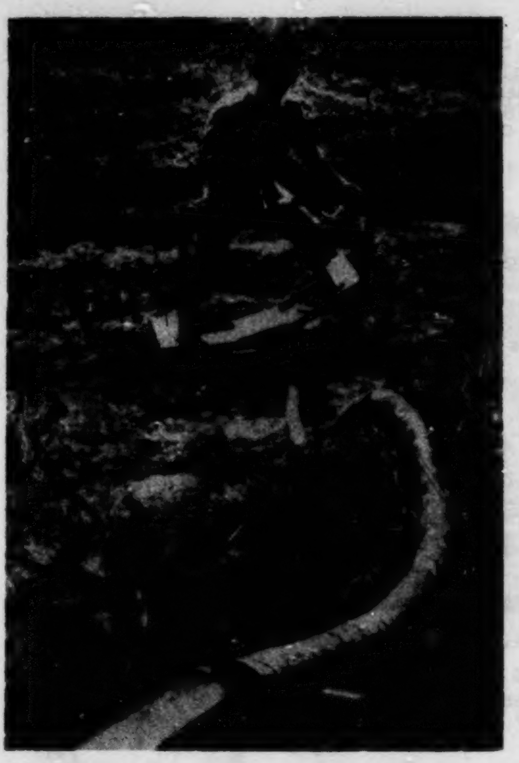


Figure 9. Foot-operated Diaphragm pump developed by the International Rice Research Institute.

Other designs for foot-driven water pumps are possible. Figure 10 shows a modified bicycle frame model capable of lifting water from a river or stream up to an irrigation channel. This pump could be used in the same situation as the bellows pump just discussed. The pedals chain and sprocket in the bicycle frame are used to drive an Archimedes screw, or auger, submerged in the water. The rotation of the screw lifts the water to an outlet several feet above the surface of the river and could either dump it into irrigation ditches or into a pipeline for use elsewhere.

Figure 11 shows a pedal-powered pump designed for boreholes or wells. Again the basic power mechanism is simply a bicycle frame. The tire has been removed and the rim drives a loop of chain onto which either rubber washers or balls are attached at regular intervals. The chain runs through a tube extending into the well, and when the operator pedals the bike the tightly fitting balls or washers lift water trapped between them to the outlet at the top of the well. From the outlet the water is delivered to any sort of catchment vessel desired.

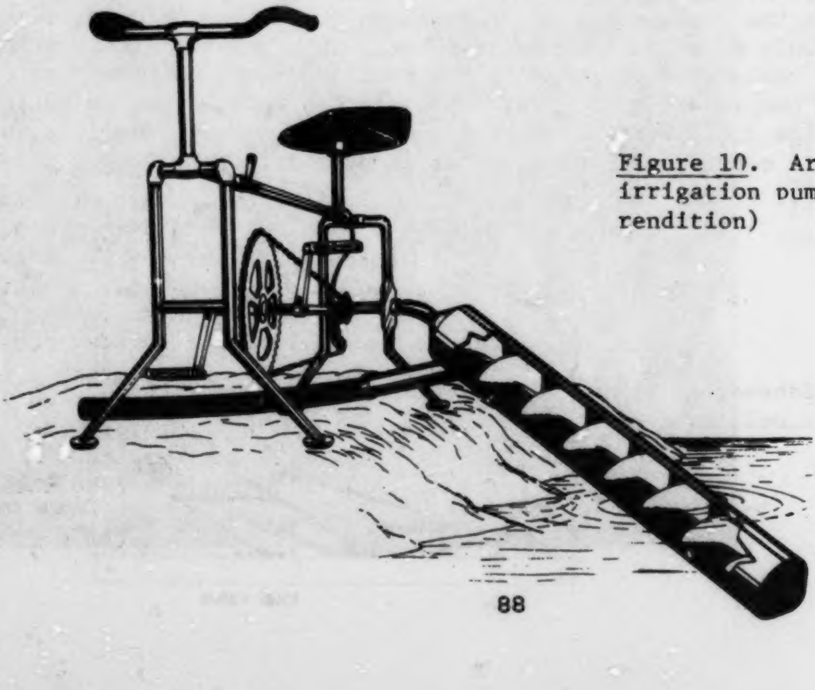


Figure 10. Archimedian-screw irrigation pump (artist's rendition)

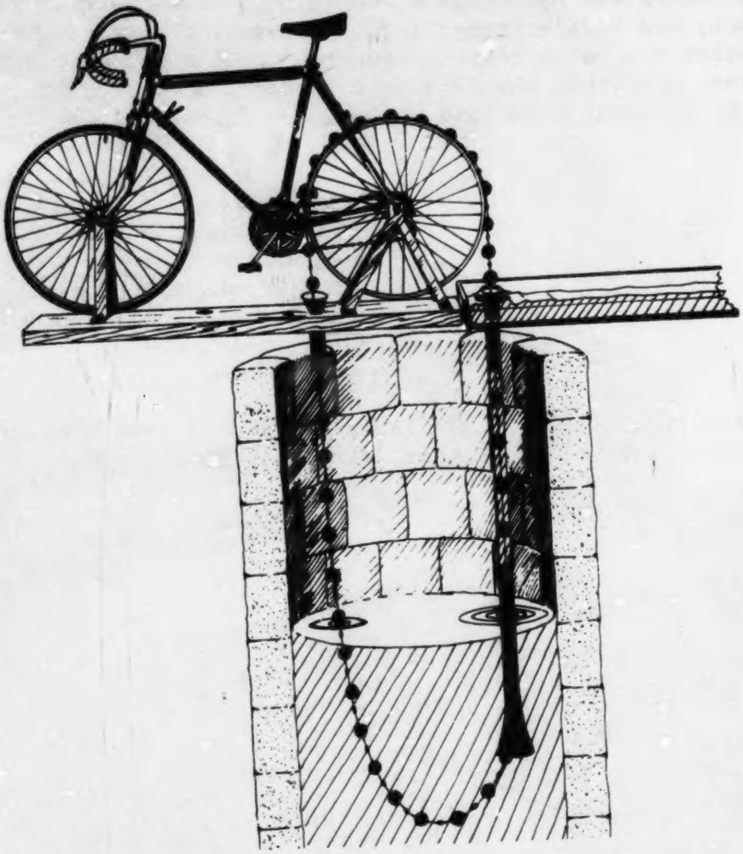


Figure 11. Ball and chain pump (artist's rendition).

This brief listing of possible pedal-driven machines is far from exhaustive. There is considerable potential for the development of more widespread application of stationary pedal power. With the rising cost of fuels, new applications of this technology not previously seen as useful or desirable can be found in both developed and developing countries, for a variety of functions in rural areas lacking electric power, and for certain tasks in urban areas. A major obstacle to such development, however, is the lack of organizations dedicated to the design and testing of prototypes. There is little incentive for commercial firms to undertake such work, since there is no near term financial return as of now. Not insignificantly, the whole idea of solving real problems by simple means--rather than by computers--is foreign to most scientists and research engineers. However, the climate of opinion is changing, and there are organizations like the

National Center for Appropriate Technology, Volunteers in Technical Assistance, and Rodale Press, Inc. in several countries where simple technologies are being taken seriously. With aid from organizations like these, the world should come to recognize that the technological simplicity of pedal power has application for us all.

[Article compiled from materials
and illustrations from Chapters 2,
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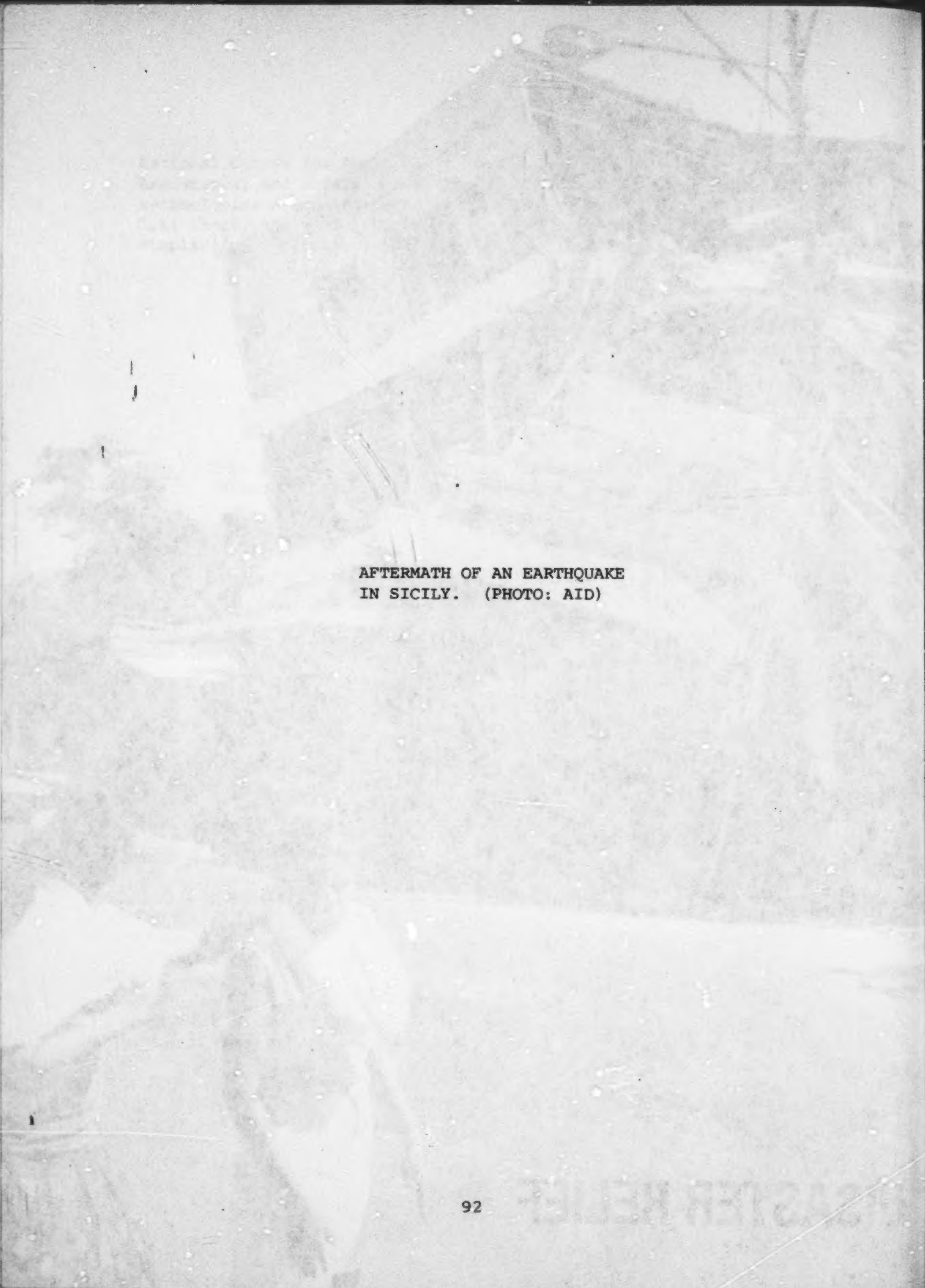
ISASTER RELIEF



AFTERMATH OF AN EARTHQUAKE
IN SICILY. (PHOTO: AID)

Planning for Disaster: The Preparedness Dimension in Emergency Assistance

Michael R. Whiteman

[Being prepared and equipped to handle a disaster is becoming an increasingly important function of emergency assistance. Information on disaster-prone parts of the world, and the lessons from experience with past relief efforts, are the essential ingredients of a preparedness program.]

Third World countries, with limited resources to spare, can ill afford the added burden of health problems, rebuilding of cities and villages, food scarcities and the budgetary drain resulting from natural and man-made disasters. Forward-moving development is interrupted, and a dependence upon outside sources of aid can develop. While floods, volcanic eruptions, storms, fires and famine may not be within man's control, the extent of their devastation and the toll taken in human lives often can be. The effects of many disasters can be minimized and the costs of recovery reduced by planning and preparedness measures.

In 1964, the U.S. Agency for International Development created a disaster relief office. The Office of U.S. Foreign Disaster Assistance (OFDA) coordinates all U.S. government foreign disaster assistance, and to a large degree coordinates public and private disaster assistance from the U.S., as well as working closely with international organizations; it also engages in planning preparedness activities, some of which are described below. Through the years since 1964, as a result of the experiences of organizations such as the Office of the United Nations Disaster Relief Coordinator (UNDRO), the League of Red Cross Societies, CARE and others, a great deal of sophistication has been gained in how best to

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provide assistance. The major questions confronting relief organizations to which answers are being sought are the following: What supplies and expertise are most urgently needed in the wake of disaster? How can these supplies and expertise be most effectively delivered and distributed? Is it possible to reduce the devastation of a potential disaster?

Disaster Preparedness in OFDA

Preparedness includes research on potential sources of disaster, predicting the nature of possible disaster, preparing inhabitants of disaster-prone areas in ways to react in case of a disaster, as well as stockpiling goods, and organizing information in various fields to make possible the most efficient response from governments and relief agencies when a disaster strikes. Relief assistance agencies have called upon medical people, urban planners, environmental engineers, sociologists, nutritionists, climatologists, geologists, agricultural specialists and a myriad of other experts to cooperate in pulling together information that might be used in disaster prediction and in advance decisions on the probable appropriate countermeasures, as well as in listing the supplies that need to be stockpiled near the potentially affected region.

The percentage of the annual appropriation to OFDA spent on preparedness measures, though a minority share, has steadily increased over the past four years; and indications are that the trend will continue. This wider view of the scope of disaster-related assistance is supported by consideration of the importance of natural and other disasters in setting back development and economic growth.

Preparedness measures can be taken by two different parties: the assistance agencies, and the disaster-prone countries themselves. In the area of aid agency preparedness, OFDA has developed some interesting programs. Drawing on field information assembled from disaster relief performance, OFDA is attempting to develop a way of determining what can be inferred from experience. The particular activities in a disaster relief effort are analyzed and assessed by degree of success, with reasons given for the results. These judgments are recorded and filed in a retrieval system called "Lessons Learned." This information is cross-referenced in a number of ways, which helps OFDA to avoid the mistakes of previous relief activities when responding to a disaster situation, and to determine what looks to be the best remedy found from the past attempts without performing research. The Lessons Learned system could in time evolve into a useful reference source to assist in deciding such questions as what quantities of which commodities are required to care for what number of people in one particular kind of environment or situation.

Emergency shelter--an example. OFDA has learned from experience that there are some essential factors that must be taken into consideration when providing emergency shelter. Both the errors and the sound decisions made in the past with regard to any aspect of temporary shelter provide the inputs into the information bank. Factors to be taken into account are: how long the temporary housing is to be used, under what environmental conditions it is to be used, how many people will be using it, and what cultural factors such as modesty, male-female interaction, etc., need to be considered. With judgments, opinions and data based on past experience available, more realistic shelters can be provided by taking into account factors such as cost, cultural and environmental acceptability, and transportability of the final product. Two kinds of action can follow: 1) general-purpose shelters adapted to disaster needs can be stockpiled in strategic locations; and 2) where these general-purpose shelters are not suitable, the particular shelter form most appropriate to a local situation can be ordered promptly when needed.

Using Lessons Learned, AID has concluded that the following factors warranted consideration in supplying temporary shelter for use in emergencies:

1. For the day after the disaster and for several days beyond, it has been observed that disaster victims are willing to accept nearly any shelter that is available, regardless of how crowded and uncomfortable it may be. Living in schools, churches or sharing homes with extended family have been found to be acceptable for this period. This provides time for temporary housing to be dispatched and distributed.

2. After this initial period is over, and if permanent housing is not yet available, temporary lodging should provide a minimum of 20 square feet (two square meters) of floorspace for each family member and should provide some visual privacy. Housing in quarters this crowded will probably remain acceptable as long as it is apparent that permanent housing will be available within a month or so.

3. For a period of longer than a month, at least 25 square feet of floorspace for each family member is desirable.

4. The tent developed by OFDA measures 10 feet by 14 feet, providing 140 square feet of floorspace. This would house a family of six adequately for up to a year, or a larger group for less time. Using bunk beds, a family of eight could live for several months with a minimum

> of discomfort and inconvenience. And all of this is obtainable at a cost of about $75 per person including the bunk beds. Lessons Learned in the past have shown the need for: adequate ventilation; extra long tent pegs for wind resistance and for sandy soil; and tent flies (a second roof above the first) where rainfall is heavy.

Today, stockpiles of 8,000 to 10,000 tents of the kind described are kept in Guam, Italy, Singapore and Panama and can be quickly moved by commercial or military aircraft to any point in the world. They are kept packed and palletized, ready for airlift.

Related activities. Information is also provided for assistance agencies through country profiles, which OFDA is in the process of producing. Thirty-eight have been completed to date. The profiles are relatively exhaustive catalogs of information on selected disaster-prone countries which may be referred to quickly in case of a disaster, or in developing disaster preparedness programs. The profiles contain data on many different conditions relevant to disaster assistance measures--the capacity of airports to receive planes; what local needs are likely to be; what distributional networks are presently in place--or if not in place, how such networks might be set up; local conditions that would make certain supplies inappropriate (e.g., dietary traditions, or climatic and topographical factors); contact lists, and so on. These profiles are updated on a regular basis.

The second half of the assistance equation--helping the disaster-prone countries develop their own preparedness programs--is also being addressed. Regional seminars, technical assistance, and various other measures are increasing the capacity of affected nations to minimize the economic and social impact of a disaster by their own efforts.

The Office of the United Nations Disaster Relief Coordinator (UNDRO), et al.

UNDRO, in addition to serving as a clearinghouse and coordinator for the disaster relief activities of governments and disaster assistance agencies, is also working in disaster preparedness. This organization has developed a series of guidebooks on disaster mitigation, providing the best current information on areas of necessary action in post-disaster situations. In its role as an international coordinator, UNDRO is also mobilizing work on pre-disaster planning. UNDRO, with a limited budget, relies on the specialized skills in the World Health Organization (WHO), the World Meteorological Organization, the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Environment Program (UNEP) and HABITAT for its

Three principles of the United Nations
Disaster Relief Organization (UNDRO)

- Natural disasters constitute a formidable obstacle to economic development
- Many disasters can be prevented
- The most basic preventative measures are often the least expensive

development of preparedness plans and strategies. This includes research on the causes of disasters, on their health consequences, and such preventative measures as more disaster-resistant housing and zoning. UNDRO also helps sponsor international seminars and provides technical assistance. The United Nations Development Program (UNDP) representatives in countries around the world usually double as the representatives of UNDRO, thus underlining the link between economic development and disaster occurence. National relief agencies in Sweden, Canada, France, England, West Germany and other countries are also carrying on active work in the areas of disaster assistance and preparedness.

Conclusion. New sources of information for preparedness are becoming available. Remote sensing provides a means of monitoring potential agricultural disaster, as well as disaster-producing storms. Seismological technology is developing to a point where earthquake prediction is coming somewhat closer, and better housing design for quake-prone areas is possible. Information sources like these at the disposal of the international community can contribute a great deal to progress, measured in lives saved and in faster recovery from disasters, with less wasteful or misconceived efforts at remedial action.

[Information on the Office of Foreign Disaster Assistance was provided by Jeffery Clark and Margaret McKelvey of U.S. AID. Information on UNDRO was provided by James Morentz, Editor, Hazard Monthly. Materials on emergency shelter came from Disasters, Vol. 4, No. 1, 1980, pp. 39-44.]

Emergency Shelter

Ian Davis

[Before appropriate building designs or the pertinent guidelines for their selection can be laid down for post-disaster housing, the success or failure of previous emergency shelter programs must be considered. The evidence and conclusions presented here are based on records from seven disasters: earthquakes in Skopje, Yugoslavia in 1963, Gediz, Turkey in 1970, Chimbote, Peru in 1970, Managua, Nicaragua in 1972 and Lice, Turkey in 1975; war damage from 1972-1973 in Bangladesh; and Hurricane Fifi which affected Honduras in 1974.]

> "It is clear that we need to understand the underlying structure of a culture and its relation to the physical forms before we can design. This knowledge must be specific rather than general, both for design and implementation, and open-endedness may be an important consideration. We must study the vernacular forms since they show most clearly the relations between life styles, values and physical form, the relation of social structure to dwellings, dwellings to the larger environment and so on. The traditional housing and settlement forms, and their associated social and cultural patterns, should be seen as the point of departure rather than being ignored."
>
> A. Rapaport, The Ecology of Housing, 1973.

Donor Designs

Past experience shows that the overwhelming majority of shelter and housing systems used in disasters, although sometimes using imported materials, are indigenous designs, locally constructed and often indistinguishable from local housing. Donor countries

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have contributed three other types of design: advanced technology designs, advanced techniques used to modify existing traditions, and designs based entirely on local traditions.

Donor solutions to design problems are a comparatively recent phenomenon, coinciding with the development of aid, rapid transportation and the growing spirit of internationalism. There has been no shortage of proposals. Many ingenious but often impractical ideas emerged from a competition on emergency shelter, held by the International Union of Architects in 1975. Proposals ranged from a floating fishing village of emergency units to projects in: cardboard, pneumatic tubes, canvas, plastic, aluminium frames, fiberglass, sprayed concrete and polyurethane. In sharp contrast to these designs which unquestionably rely on very advanced technology, there was a very thoughtful prize-winning proposal by a group from Carnegie-Mellon University. [See Development Digest, April 1974, pp. 83-90.] They developed a proposal that relied on indigenous materials and indigenous building skills, but used western expertise in devising the proposal. The basic unit is a series of "A" frames made of bamboo which can be extended for varying lengths, with a roof of thatch or leaves (see Figure 1). This concept, field tested in Bangladesh, re-

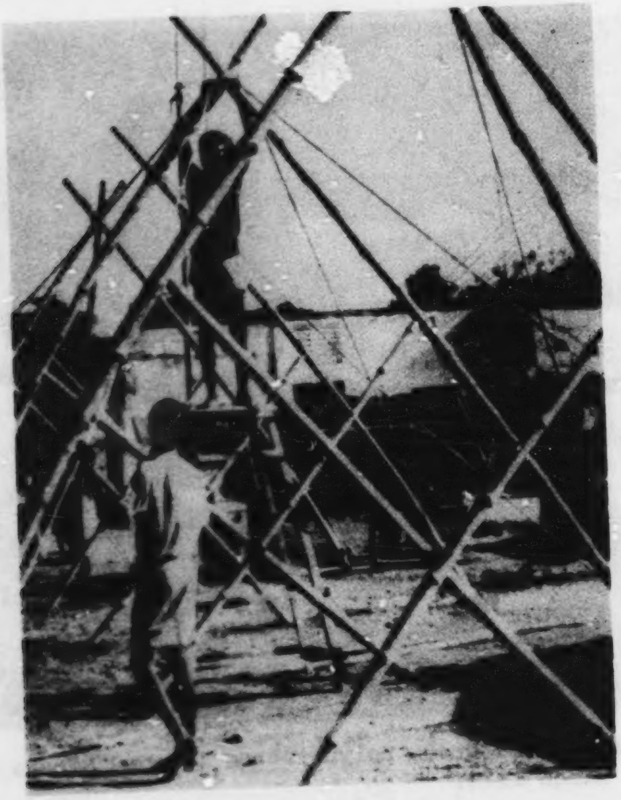

Figure 1. Bamboo "A" frame housing being built in Bangladesh, designed by the Cuny/ Carnegie-Mellon group.

sults from a very careful analysis of an existing situation which included a study of cultural and economic patterns, local climate conditions, as well as exploring the performance of existing vernacular (local) housing. Thus Rapaport's warning quoted above was followed very closely.

High technology designs. Many manufacturers have products available which they classify as disaster shelters. There are at least 18 international systems of emergency shelter, and over 21 manufacturers of prefabricated houses who are anxious to use their products in disaster situations. However, the response to these designs by both relief agencies and governments has been very small. Reasons for this lack of interest include low relevance of the products to the needs of the situation, and high transport costs. The U.S. Department of Housing and Urban Development commissioned a major study of all manufactured products for disaster relief, published in 1974, which shows a very interesting approach to comparing the cost-effectiveness of housing systems.

The main western "advanced technology" systems which have been adopted are the West German Red Cross Bayer polyurethane igloos--1,400 units have been used in Turkey, Peru and Nicaragua (Figure 2), and the Oxfam polyurethane hexagonal igloos, used in Lice, Turkey where 453 units were produced.

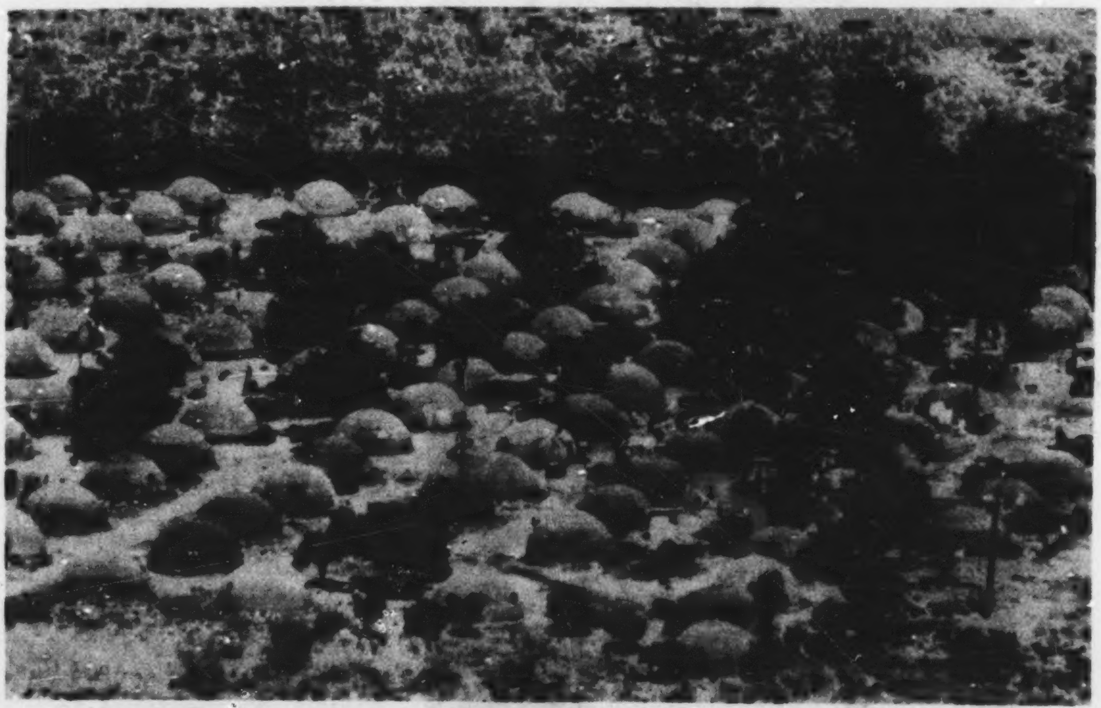

Figure 2. Bayer/W. German Red Cross Polyurethane Igloos, Masaya, Nicaragua, March 1974.

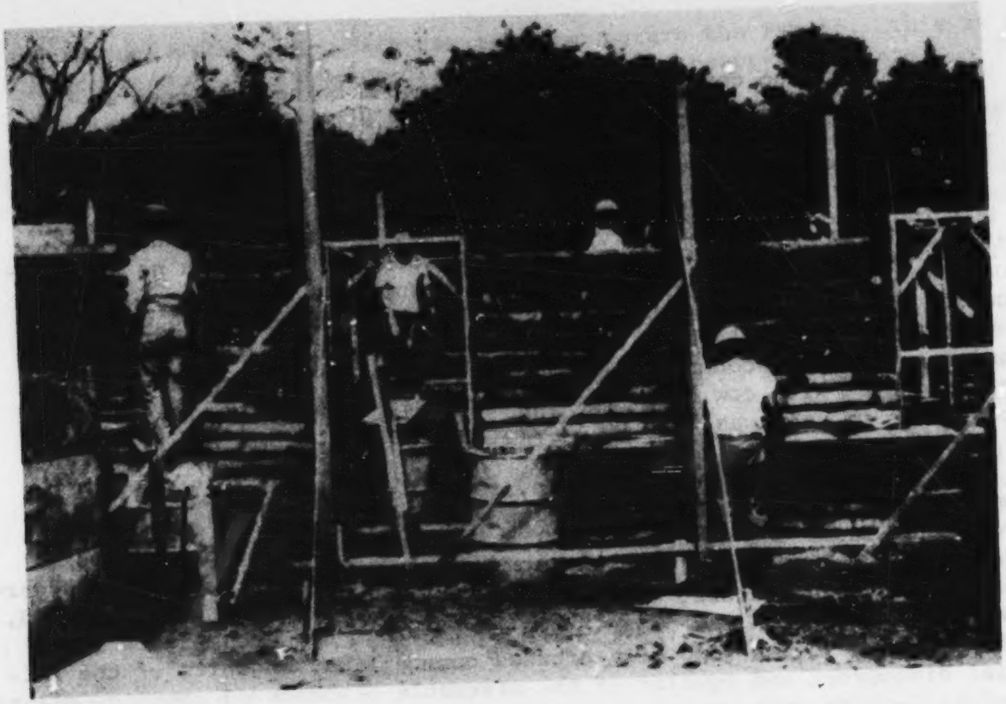

Figure 3. Masatepe, Nicaragua. Stack-sack permanent housing. Sacks of cement and sand are dipped in water, then spiked over vertical short steel bars, thus forming a simple type of "reinforced concrete" wall, resistant to earthquakes.

Advanced techniques using local materials. Other examples of western designs have used advanced technology with existing local housing traditions. Notable examples include:

(1) The Carnegie-Mellon prototype housing using triangulated bamboo "A" frames with thatch covering.

(2) The C.A.R.E. 'Cinva-ram' housing system has been used in many contexts, including Bangladesh where consolidated earth (a mixture of cement and soil very firmly compacted to form bricks) is used for the walls of houses. A project for 100 of these homes was financed by Oxfam.

(3) Stack-sack housing in Peru and Managua, using a technique of sand bags filled with cement and sand, erected like brickwork with small reinforcing bars spiked into the bonded sacks as they are erected (See Figure 3).

(4) Tilt-up concrete housing. A system being developed in Choloma, Honduras after hurricane Fifi where concrete walls of units are poured on the ground to save formwork costs, then tilted upright by a metal erector.

Indigenous techniques. Finally in the realm of donor housing, there is the type of solution that uses local skills (with no significant modification) and local materials. Numerous examples of this could be found, for example the rural housing produced in Bangladesh by EFICOR and now the NEED consortium. About 1,300 homes were built using a frame of wooden posts with partitions of woven jute, sometimes coated with cow dung, and a corrugated iron roof. The total cost of each unit was $123.00 (£52).

Tents. For hundreds of years, tents have been the basic form of emergency shelter. After the Lisbon earthquake of 1750, Antonio Pereira de Figueiredo described peoples' reaction: "The general desire was to get out of buildings into tents or huts, and to sleep in the garden rather than indoors, even if one's home still stood safe and sound, and for this reason the great camps on the high and open places round the city were for a long time crowded communities, in spite of the initial discomfort and squalor of the miserable bivouacs of matting, plants, and sail-cloth under which many of the squatters spent their first nights."

Tents also constitute one of the few types of mass shelter that are stockpiled. A.I.D. keeps stockpiles, containing up to 10,000 frame tents, in various key places throughout the world--Europe, Asia and Latin America. The Red Crescent in Turkey and Iran also stockpile bulk supplies of up to 20,000 ready for use which are manufactured by refugees of one disaster, ready for the next.

Two significant problems with canvas tents are their rapidly rising cost, and their weight in transit. It is hoped that the plastic, woven polythene tents, being developed specifically for disaster situations by a Japanese firm, will be both lighter and cheaper. These were developed to a specification worked out by Jurg Vittani of the League of Red Cross Societies, and so far have been used in flood situations in the Philippines, as well as Vietnam, Laos and Cambodia. However, reports have yet to be provided on their performance.

The only attempt, to my knowledge, of town planners applying their particular skills to tent location was the layout Fred Cuny worked out for El Coyotepe camp in Nicaragua. This produced a humane environment in sharp contrast to the usual regimented military camps; it was based on the use of family clusters, localized cooking and sanitation units.

Another obvious problem with tents is climate; most designs are not resistant for long periods to extreme heat or cold, or to high winds. Finally, there is the problem of the homeless bringing their scraps of furniture with them, which can easily puncture the fabric. This is a major reason why agencies like Oxfam use only heavy-duty tents.

Advantages unique to tents are the fact that they can be erected within hours, and their relative lightness and compactness for bulk transit. Various proposals have been made for the use of inflatable structures, or even large marquee tents which can then be subdivided internally into small cubicles for individual families. Although there are cost reductions in such proposals, there remains the apparent dislike of families for multi-family dwelling units.

Research activity. One of the most encouraging activities to emerge in recent years is a concentrated research effort to establish criteria for emergency shelter. Unfortunately, much research work has been non-productive in that a misdirected emphasis has been placed on designing a single disaster shelter to solve the whole world's shelter problems--an impossible aim given the wide range of cultural and climatic variables. Much worthwhile research activity in the housing and disaster sphere has been in the area of pre-disaster planning: to devise building codes, better siting of houses and simple, realistic ways to prevent buildings collapsing.

Local Responses

In addition to the "external" contributions discussed so far, there are a number of "internal" responses to disaster situations, which may operate simultaneously and result from both official decisions and the *ad hoc* decisions of individual families.

Extended families. One major *ad hoc* response is reliance on the extended family. About 250,000 people were homeless in the Managua (Nicaragua) earthquake, but it would appear that 90 percent were absorbed by families and friends. A census taken four weeks after the earthquake in four outlying towns, swollen with refugees, indicated that no less than 130,000 in these towns alone had been absorbed by extended families. Seven weeks after the earthquake a further census revealed that 80,000 were still in these adopted homes. However, we cannot deduce from this that a similar response will always take place. For example, the extended family "sponge" cannot function in long-term disaster situations such as the Sahel drought, for the obvious reason that everyone is affected. Another context where it won't function is in the refugee camps of Bangladesh or Bengal, where people have been uprooted from their environment. Even in rural situations like Lice, Turkey where villages are more self-sufficient with little outside contact, initial studies confirm this response is unlikely to take place.

However, in urban areas, particularly where urbanization has been rapid (as in most cities in the developing world) there will exist strong rural links for most, if not all families, and this is of great benefit after a disaster.

Self help. Another common response is for the families to rebuild their own housing. The ability of most families in the developing world to build their own houses is often overlooked, since we have been getting away from that basic skill in the western world. So in assessing the priority of shelter, it should be noted that a very large percentage of post-disaster reconstruction will be taking place irrespective of donor provision or public regulations (Figure 4).

In the post-war situation in Bangladesh, out of a total housing need of 1.5 million units, the relief agencies built a total of 450,307 units between January 1972 and June 1973, while one million

Figure 4. Patzicia, Guatemala, six days after the earthquake of February 4, 1976. House owners rebuilding their homes.

were probably rebuilt by owner/builders in the same period without special assistance. It is often argued that disaster victims are in such a state of shock after a disaster that they cannot fend for themselves. Perhaps this is true where there is extreme malnutrition, or in the dehumanizing conditions of the refugee camp; but there is evidence that people show high levels of initiative in most disaster situations.

Underuse of shelters. The unwillingness of refugee families to occupy donor housing is another frequently overlooked response. In the town of Masaya, outside Managua, igloos provided by the West German Red Cross (see Figure 2) were rent-free housing. Despite this, only 75 out of 310 units were occupied. An analysis of provision in other situations tends to confirm the fact that low occupancy is more likely to be the norm than the exception. The A.I.D. wooden houses in Managua were only 35 percent occupied eleven months after the disaster. In Chimbote the multiple family units built by the Peruvian government and A.I.D. were again little used, as were the United Nations shelter units. In Skopje seven months after the earthquake only 179 families were living in the Nissen huts and quonset huts provided by the British and Americans; the capacity of these units was at least four times that total.

Reasons for this underuse may include: overestimates of the homeless population, excessive volumes of aid; the mislocation of the units --often away from bus routes, a vital requirement as work gets back to normal; cultural rejection of unusual forms of housing (see Figure 5); the almost universal hostility to multi-family units; and finally, the fact that as more permanent housing becomes available it is seen as a better alternative. From the use of extended families, the desire of people to rebuild their own homes and the underuse of so many forms of shelter supplied from the outside, it seems there is a strong tendency to exaggerate the priority or importance of shelter provision, and relief agencies may have been wise to give it low priority.

The Official Response

One obvious need in any permanent building work in a disaster-prone area is to advocate that all public buildings, schools, hospitals, churches, and police stations are built to such standards that they will not collapse in any disaster. Thus, they can be brought into immediate use as morgues, dispensaries, food distribution centers or emergency shelters. In the Managua earthquake schools and churches collapsed, and it seems that new schools have been rebuilt in a very vulnerable form. If this is the case, it is a very short-sighted policy. However, for obvious reasons the time span of this emergency use is limited, as normality returns and the buildings are required for their original purpose.

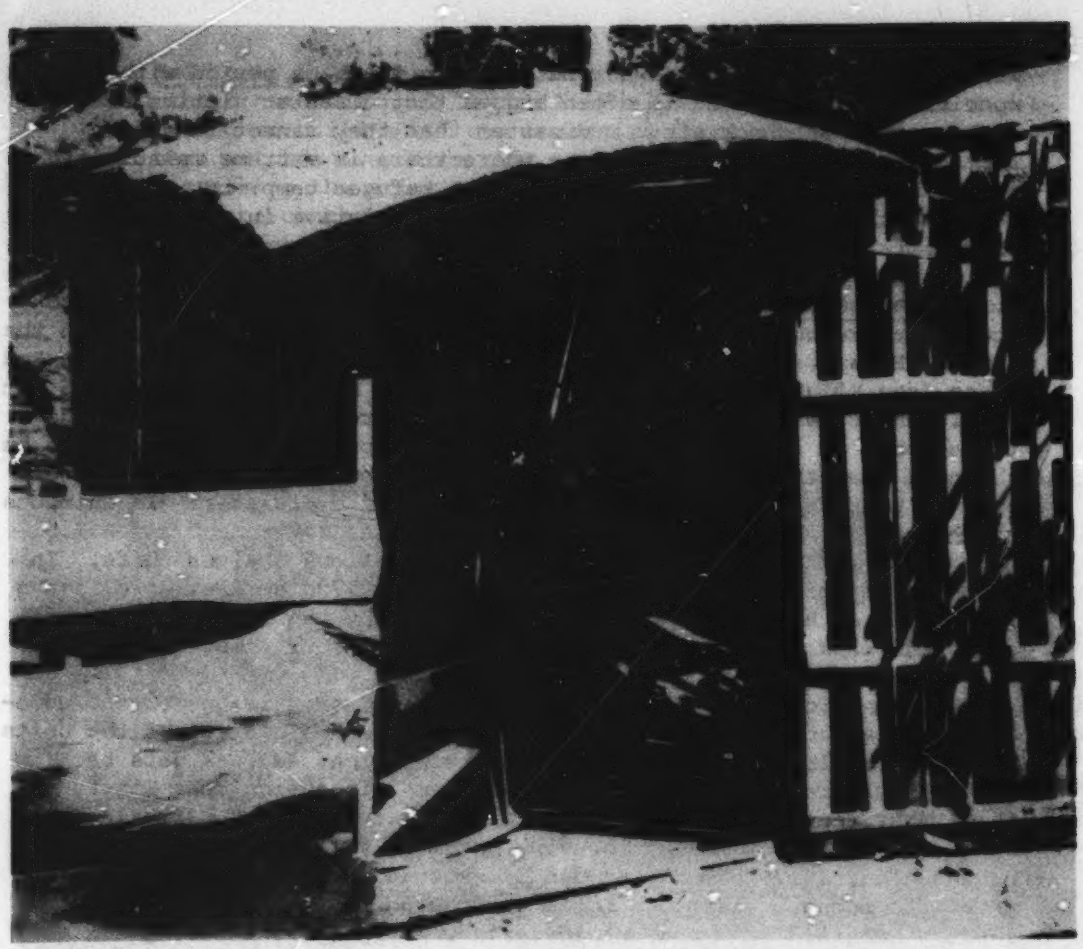

Figure 5. Bayer/W. German Red Cross polyurethane igloos, an example of the "improvisation process"--note the way a less acceptable "round" igloo has been converted into a "rectangular" house.

One role that outside consultants can play is to detect the intrinsic weaknesses of the local permanent forms of architecture relative to their vulnerability to disasters. Although traditional forms respond to cultural, economic and climatic factors, they rarely respond to disaster hazards--with the possible exception of the Japanese lightweight timber house.

Sometimes the official response is to evacuate the area. In numerous disaster situations governments, worried about health risks or food availability, have attempted to evacuate all inhabitants except the men needed to clear rubble and assist in relief work. However, they may not stay away. In Skopje, for example, 150,000 left for home within the first three weeks. Families did not like being split up, children could not speak the language of different Yugoslav republics, and the net result was that within 2½ months they had virtually all returned. It is worth noting that the twin desires, to return to one's home and to remain with one's family, are so powerful that people will tolerate almost any degree of discomfort to achieve them. These attitudes are very important when various strategies are considered.

Lessons From Experience

Cost Factors. In the data from the seven disaster case studies covered here, the number of variables makes a simple comparison of cost figures almost meaningless. However, certain patterns emerge.

(a) *The cost of temporary donor provisions using western technology may be higher than that of permanent housing.* In Gediz, precise costs of permanent housing are not available, but it is highly probable that the temporary igloos costing about $31 per square meter were more expensive than the new permanent pre-fabricated units. In Lice, although five years had passed since Gediz, a similar situation emerges. Again precise costs of the new pre-fabricated houses have yet to be ascertained, but the approximate cost of a house, including sanitation and services but without costs for infrastructure is $31.70 per square meter, compared with $31 per square meter for the Oxfam polyurethane units. If the transportation costs are added and averaged according to the number produced then the total cost of these temporary plastic units rises to $40.70 per square meter.

The conclusion is that in terms of value for money the high technology donor solutions (German igloos and the Oxfam hexagonal units) are comparable in price to fully serviced permanent housing. If development costs for the igloos are added, the donor situation would be seen in an even more unfavorable light. Reasons for the high cost include expensive imported materials, high western labor costs in comparison with labor rates in the developing world, and high transport costs. In simple terms this implies that in Lice 71.8 pre-fabricated, fully serviced houses costing $2,000 each could probably have been purchased for the same price as 453 temporary structures.

(b) *The cost of donor shelters becomes comparable with local provision when indigenous materials and techniques are adopted.* The Carnegie-Mellon University "A" frame units cost about $4.37 per square meter, while the EFICOR rural housing in Bangladesh (units built using a frame of wooden posts with partitions of woven jute, sometimes coated with cow dung, and roofed with corrugated iron) costs about $10.00 per square meter. There are no local statistics to compare with these figures, but obviously when local skills and local materials are used the price is similar to local provision, even though finance may come from an outside donor.

In both of these examples the actual cost of the units was determined in advance of the design to make certain that the shelters were economically viable for the occupants. This is obviously vital; but it is quite impossible in the case of donor shelters relying on western products which cannot be modified to suit prevailing market conditions.

(c) *The obvious cost saving of multiple units emerge from these figures.* The "Basha" multiple housing units, used in the Bengal refugee crisis in 1971-72 cost about $1.12 per square meter; and with the semi-detached "A" frame units by Carnegie-Mellon, the idea of dual units has helped to keep the cost down to $4.37 per square meter. It is surprising that the obvious cost savings from units accessible from each side have not been exploited more frequently.

Timing Factors. (a) *Emergency shelter.* The overriding impression from an examination of donor provision is the extensive time it takes to arrive and be installed. In the seven case studies, the first occupants rarely moved into donor housing in under 60 days, and in some cases the figure is nearer a hundred days. Reasons for the delay include the time for setting up projects (with evaluation missions reporting back to the home base), transport difficulties, government red tape and land tenure issues. In contrast, figures for tent usage show they are normally occupied the night after the disaster and most camp sites are established within the first week.

(b) *Permanent housing.* The figures for the occupancy of permanent housing are relevant in the cases of Skopje, Managua and Lice. In Skopje, 210 days after the earthquake, 14,000 houses were completed. In Managua permanent houses were being completed within 40 days of the earthquake, while in Lice 1,500 homes were completed by day 56. The conclusion is that it is possible, given the governmental will and rapid land acquisition, to build permanent shelter very rapidly.

Conclusions

On the basis of the evidence discussed so far, it is possible to set down certain key criteria for emergency shelter. Provision should aim to:

(1) utilize local resources, which will be readily available;
(2) avoid the imposition of novel solutions, that may well be rejected along with unfamiliar foods;

(3) encourage a labor-intensive solution, thus providing much needed work (possibly of high therapeutic value after a disaster);

(4) recognize the need for shelter provision in different areas to vary according to local cultural patterns, local materials and local climate;

(5) recognize that it is better to sell or rent than to give, even if the rent is minimal. This helps to preserve the dignity of the occupants, and I suspect that when shelter is offered free of charge it may lead to low occupancy. However, the people needing shelter may be among the poorest of the population; for the housing to be viable in their terms it must be very cheap. Housing for the poor must never cost more than twice the occupant's family annual income,

(6) recognize that emergency shelter must be rapidly available. An American study, undertaken for the National Academy of Sciences, indicates that emergency shelter is required within the initial 48 hours and temporary housing in the first ten days. However, only in the case of the Gediz was "donor housing" occupied in under 60 days. If shelter cannot be provided within three days, or one week as the absolute limit, then it has little validity, since from this time onwards the emphasis must be towards permanent housing recovery.

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Living with Earthquakes

D. J. Blundell

[Earthquakes--where and with what frequency do they occur? What seismological changes lead to them? What advances are being made in their accurate prediction? What measures might be taken to mitigate their impact? These questions and more are addressed in the following article.]

Earthquakes--Where, and How Often?

With the memories of recent earthquakes in China, Indonesia, Italy, Guatemala and Turkey, it is timely to reconsider just how much longer we must accept such tragedies. An earthquake is a natural occurrence, but does the disaster that follows also have to be regarded as an "act of God"? Disasters are man-made where they relate to losses in human lives and property--if we could avoid living near earthquakes then no such disasters would arise.

Earthquakes occur mainly along well defined zones around the earth that are long and relatively narrow belts. The majority of earthquakes occur in a belt peripheral to the Pacific Ocean on the west coast of North and South America, or in Japan and the Philippines; and along another from Indonesia through northern India and Iran to the Mediterranean; major earthquakes also occur regularly across a wide region of China and eastern USSR, while occasionally causing damage in places well removed from the main seismic zones. Earthquakes are monitored on a global basis by a world-wide network of seismological observatories which record the arrival of seismic waves (vibrations

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from inside the earth) generated by the earthquakes that have travelled through the earth. The *focus* of each earthquake--the point inside the earth from which the seismic waves emanate--and the *epicenter*--the point on the earth's surface directly above the focus--can be located from an analysis of the seismic records. A measure of the magnitude of the shock is given from the amplitudes of the seismic waves that are recorded. A logarithmic (to base 10) scale of magnitude is used, called the Richter scale, in which earthquakes of magnitude 6 or greater are all potentially dangerous. Thousands of minor earthquakes occur each year around the world. Hundreds of these are strong enough to cause a noticeable shaking of the ground, and perhaps twenty or so are great enough to cause major damage. Fortunately, most of these occur in regions remote from habitation, but with the ever increasing spread of population around the globe the risks of further disasters must be increasing.

At present there seems to be no way of preventing earthquakes from occurring; and if it is accepted that they occur over sufficiently wide and valuable areas of the world that we have to live with them, the question is then to know how best to mitigate their hazardous effects. In a zone of earthquake risk one has to be prepared to counter this hazard, but unfortunately it is but one of life's hazards and may by no means be the most pressing. After all, the loss of life from earthquakes is small compared with road accidents, preventable diseases, wars and other man-made hazards. Even in a highly active region, damaging earthquakes may only recur at intervals of 30-50 years, so it is not surprising if governments find other priorities taking precedence over earthquake hazards. Consequently, to judge their priority, one needs to assess the risk from earthquakes; some means of forecasting their future occurrence seems imperative.

Forerunner Effects

The past few years have seen a considerable advance in finding signs to indicate an impending earthquake. Unfortunately, public expectations of a forecasting service are rising faster than research progress, and scientists are becoming increasingly wary of committing themselves. Perhaps the most striking advance has come with the discovery by Russian seismologists, later confirmed in the United States, Japan, and elsewhere, that on some occasions, changes in the ratio of the velocities of propagation of longitudinal *(P)* and transverse *(S)* seismic waves occur in the vicinity of the focus of an impending earthquake. (This refers to shifts in the speeds of movements of earth vibrations running at right angles to each other as measured on the earth's surface.) It seems that the 10 percent or so drop in the ratio V_p/V_s observed ahead of an earthquake is due to changes in the mechanical behavior of the ground when it is under pressure and stressed near to the breaking point. Evidence suggests that this has to do with the flaws or cracks in the rock; the effect is called *dilatancy*. There is also evidence to suggest that the larger the magnitude of the earthquake, the larger the volume of rock actually involved in the earthquake source region. This has been used to explain the observation that the time period for which *Vp/Vs* decreases ahead of an earthquake is related to its magnitude: the longer the time delay, the larger the earthquake. It is this observation that has given rise to the hope that the phenomenon may be sufficiently prognostic to predict not only the place but also the time and magnitude of an impending earthquake. But the observations of the *Vp/Vs* changes have only been discovered, in most cases, after the event. Only one or two claims have yet been made of using it successfully to predict in advance. To put it into practice, a network of sensitive seismometers must be located within a few tens of kilometers of the earthquake, and even then the magnitude of the changes sought is only slightly greater than the accuracy of reading the records. Despite its early promise, seismologists have become somewhat discouraged by the unreliability of the method, at least in its present state of development.

Even so, the discovery of these changes in the seismic properties of the ground suggest there may be other measurements which could be made of the same physical phenomenon that might be equally or perhaps more characteristic. It gives new impetus to measurements of the deformation (i.e., changes in shape) of the ground surface, which has been monitored for some years in earthquake risk areas. Particularly across geological faults, lines have been surveyed repeatedly to observe any small vertical or horizontal movements of the ground surface. Here the problem has been to distinguish between deformation that is an elastic response of the ground to increasing stress, one which will eventually result in an earthquake when the fracture strength of the ground is exceeded, and deformation that is a plastic response which results in creep movements rather than earthquakes. Careful geodetic measurements, such as repeated surveys, the use of tiltmeters and measurements of small changes in gravity, carried out over a region where an earthquake is expected, do look to have the potential to pick out the dilatancy effect (causing the *Vp/Vs* anomaly) and they may prove more reliable as predictors. Other related observations include changes in geomagnetic field, and the electrical conducting properties of the ground. Such is the present state of the art that, in prediction, the best hope seems to lie in the comprehensive use of all these criteria together rather than relying predominantly on any one. A major effort is needed for any chance of success, so that only when the risks of disaster are high can it be sustained. Several countries are indeed making this effort, but the only successes claimed so far have come from China (see below).

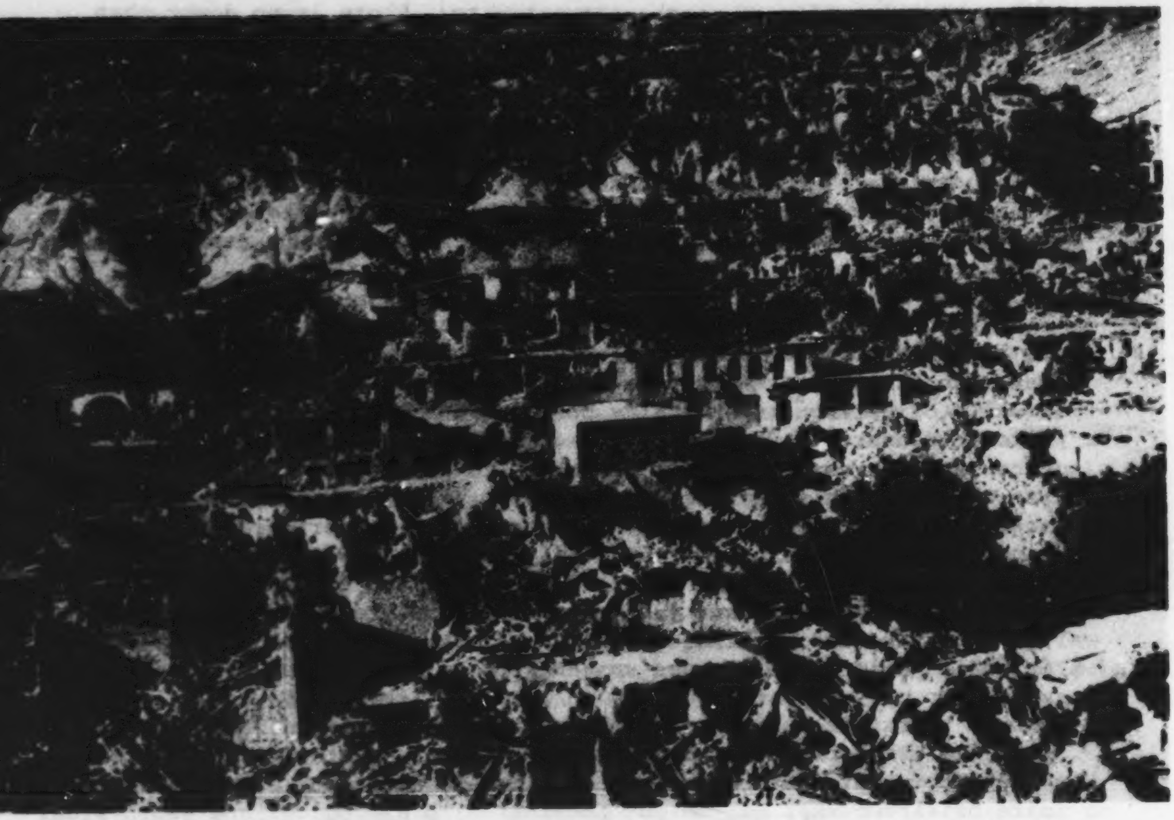

Figure 1. Scene of devastation at Lice. A general view showing the devastation at Lice in Turkey after an earthquake totally destroyed the town killing more than 2,200 people and with more being dug from the rubble by rescue workers. Army roadblocks were turning back all but essential and military vehicles on the outskirts of Lice, where there was still little to eat or drink. (Associated Press Photo from London.)

Assessment of the Earthquake Hazard of Different Areas

The first step in the assessment of area hazard is to get data on past and current earthquake activity. Seismic observatory records give information only for the present century, and in detail only for the last two decades. This time span is too short to describe adequately the pattern of seismic activity as a basis for prediction, so historical descriptive records of earlier earthquakes are an important contribution to our knowledge. In a few places where these have been studied, important information has come to light concerning the variations in space and time of past earthquake activity. There is no doubt that earthquakes are closely associated with patterns of geological faulting, and it is also clear that earthquake activity can migrate along fault zones, so that at any one location there may be periods of intense activity of perhaps 50-100 years duration with intervening periods of relative quiescence lasting 150-200 years. So, following these patterns of migration, where they can be recognized, can help to pinpoint areas where earthquake activity can be expected next. These are sometimes areas where recent activity is slight and represent "seismic gaps," possibly soon to be filled.

When relying on historical records, the size of an earthquake has to be judged by the surface effects, largely based on the damage to man-made structures that it causes, rather than on exact measurements. A scale of earthquake intensity has been devised which is a macroseismic measure of the effects of ground motion upon buildings and other structures. Since its estimation depends first of all on the presence of such structures and the ensuant damage depends on their design, construction and foundations, the scale is perforce semi-descriptive and subjective. Nevertheless it is a scale with practical value since it relates directly to the damaging effect of an earthquake, and it provides some continuity between historical records and modern instrumental recordings (which use the Richter scale). The modified Mercalli scale in common use ranges from an earthquake of intensity I which can only be detected with instruments, through V which is sizeable enough to rattle objects on shelves and cause public disquiet, to intensity XII which produces complete devastation. Historical and recent observatory information on the location, frequency of occurrence and size of earthquakes can be put together with geological and geophysical information locating active fault structures to compile seismotectonic zoning maps that provide predictive information on the probability of the extent of earthquake activity at each location. Information of this kind, however, is sparse and only a few countries, notably Japan, USSR and USA, have reasonable coverage with such maps. Other countries, particularly around the Mediterranean and in Central and South America, are making good headway in preparing this baseline information.

Earthquake Prediction in China

In the light of this kind of knowledge it then becomes possible to highlight those areas that appear to be in special danger, and to monitor these sufficiently closely for prediction to be feasible. Study of migration patterns and of the past history of earthquake activity led Chinese seismologists to suspect in 1970 that the province of Liaoning about 500 km east of Peking warranted special attention. The seismological observatory network there was strengthened, and a program of repeated leveling, surveying and other geophysical observations was put in hand. As seismic activity in the area increased and re-levelling showed ground deformation to be accelerating, the scientists became convinced by early 1974 that things were building up towards a major earthquake. The pattern of epicenters was related to a NE-SW trending fault zone, and the re-leveling indicated ground rising in the SE and subsiding in the NW with the strongest gradient of deformation near to the fault zone. The activity was also centered in a NW-SE direction about a cross fault so the likely epicentral region could be predicted. Seismic activity in 1974 had increased to five times above normal for earthquakes of magnitude less than 5 on the Richter scale. By June 1974 the combined information led to the prediction that an earthquake of magnitude between 5 and 6.5 would occur within 1-2 years near Haicheng.

Based on this, the help of the general public in the locality was enlisted, both to form teams of amateur observers to strengthen and enlarge the range of monitoring observations, and also to make practical preparations to reduce the hazards from the expected earthquake. The seismic and geodetic measurements were thus augmented with local observations of geomagnetic field, natural earth currents, the monitoring of water levels in wells and of animal behavior. At the same time, people were instructed how to act best for self preservation when the earthquake occurred; buildings were inspected, some strengthened, some designated to be evacuated; light temporary buildings were prepared, and relief services generally organized. In the ensuing months a variety of effects were noticed by the amateur observers. Water wells changed level in unusual ways, with the majority showing rises in level, a few even becoming artesian. A third became muddy and bubbling. The pattern of activity also pinpointed the likely epicentral region. Various animals, both domestic and wild, displayed abnormal behavior. Only a few individuals within any one species ever behaved oddly, but reports covering 10 different species began to add up. Mice and snakes seemed to be the most sensitive, with snakes appearing from their holes out on the ice and snow in the depth of winter, something normally unheard of. The pattern of locations where such abnormal behavior was reported was initially widespread, but it began to converge on the expected epicentral region.

Early in 1975 an earthquake of magnitude 4.8 about 80 km north of Haicheng caused some public alarm, and must surely have occasioned some doubts and misgivings among those concerned with the prediction of a major earthquake. Then, early on February 4, 1975, the seismic network recorded a swarm of earthquakes with unusual characteristics and closely grouped within the expected epicentral region. This was correctly interpreted as a foreshock sequence, which is known sometimes to precede a major shock. By midday the local authorities had been alerted and the general public were set in a state of preparedness, moving elderly and infirm to places of safety, livestock out of their barns into the fields, and congregating in open spaces. The main earthquake occurred at 7.36 p.m. that evening and was of magnitude 7.3. Because most people were in the open, casualties were very slight, even though damage to buildings was severe. In one village of 3,000 population no-one was killed, even though 82 dwellings out of some 800 collapsed completely and many others were severely damaged. In another, one child died, from a population of about 3,500, where 90 percent of the houses were destroyed. The Chinese ascribe this success in preventing disaster as much to the education and mobilization of the public at large as to the monitoring program. They claim to have successfully predicted and taken effective preventive measures for 10 earthquakes, of which Haicheng has been the most spectacular. However, success was very dependent upon the observation of the foreshock sequence, and it is clear that estimating the exact time and magnitude of an earthquake remains a chancy undertaking. With hopes raised by this success it is doubly tragic that China should suffer such calamitous losses on 27 July, 1976, near Tientsin.

Pitfalls of Prediction and Pronouncement

The unreliability of predicting the time and magnitude of an expected earthquake is well illustrated by Japanese experience. Careful observations have led to the pinpointing of several areas where a severe earthquake must be expected. In the Boso Peninsula south-east of Tokyo Bay, geodetic measurements indicate substantial ground deformation around a fault zone that has been building up since a great earthquake occurred there in 1923, but so far there has been no increase in seismic activity to suggest that another earthquake is immediately imminent. There is also evidence of the build-up of ground deformation in the region of Tokai, which has a history of great earthquakes of magnitude 8 or more recurring in 1498, 1605, 1707 and 1858. Just offshore to the south a "seismicity gap" has been recognized. But so far no other precursory phenomena have been diagnosed. More urgent signs of an impending earthquake are found at Kawasaki, an industrial town situated at the mouth of Tamagawa River, south of Tokyo. Here, releveling measurements have shown ground elevations to be rising at accelerating rates that are exceeding 10 mm/yr, as compared with 5 mm/yr observed in Haicheng. Some of the uplift can be ascribed to recovery following subsidence caused by excessive pumping of groundwater near the river, which has recently been strictly regulated and reduced. Observations of water levels in wells have shown marked rises, that could be due to the restraint in pumping. However, the anomalous uplift of the ground covers a wider area than where subsidence had previously occurred, and radio-carbon dating of well water has shown that not all of it could have been recently replenished so that the uplift must have a more deepseated source.

Kawasaki has a past history of damaging earthquakes. Some of the signs used by the Chinese to predict the Haicheng earthquake are present. The Japanese have a well-organized program of earthquake prediction research and are intensively monitoring the area. The general public are well aware of earthquake hazards and know what to do when one comes. But with uncertainty in estimating the time and size of a future earthquake, it is difficult to set a balance between maintaining a state of alert and preparedness while avoiding false alarms that can detract from the credibility of the forecast service.

This problem is equally pressing in California, where the dangers inherent in unreliable forecasting are well appreciated. Research into the social and economic consequences of earthquake forecasting is being carried out in parallel with research into forecasting itself. The hope is that research progress can be sufficiently rapid to minimize the period of unreliability; if not, the social consequences of forecasting could be more damaging than useful. It is not thought in California that they yet have the basis for a forecasting service. Scientists have already resolved that when predictive information does become available, the general public will be told straight away, but any forecast will be qualified with a statement about its reliability.

Mitigating the Earthquake Hazards

Forecasting an earthquake in time, without false alarms, can allow preventive measures to be taken, alert the public to the danger, and ensure that services are maintained. Hospitals must continue to function in the aftermath of an earthquake. Fire brigades must also function effectively to reduce the serious fire hazard that exists in any urban area. These and other public services and utilities can best be maintained if they are given advance warning. The Chinese example has shown how greatly the casualties can be reduced compared, say, with Managua, Nicaragua where 1 percent of the population were killed in the 5.7 magnitude earthquake of December 1972. Yet forecasts have their limitations since they relate to prognostications only a year, or months, or even hours ahead of the event--too late to do anything about bad design or bad construction or bad siting of the structures in which the people who are killed get buried. Most of the losses, both economic and human, are preventable only if buildings are built to be earthquake resistant.

It would be too much to expect to build structures so that they should all survive undamaged in the strongest earthquake ever known. The cost of strengthening to this extent would be prohibitive, and unnecessary in terms of the other risks we face in living on earth. But it is feasible for engineers and planners to devise design criteria ranging in complexity according to the requirements of each structure, dependent on the risks involved. Large dams and nuclear power stations, for example, need stringent criteria because of the inherent dangers of secondary hazards should they collapse. Single storey houses, on the other hand, need simple criteria. It is found that heavy roofs to provide good insulation which are not well enough supported cause many deaths, so persuading people to change their traditional methods or materials for house building can be a simple remedy in preventing tragedy where such changes are practical and affordable. Often where designs are adequate, buildings collapse in an earthquake through bad construction, so that human failings become responsible for disaster. Engineers are able to work on the basis of seismic zoning maps, where they exist, and sites of large structures can be monitored before and after construction. But there are still major gaps in our knowledge. For example, very little is known about the pattern of ground movement in the epicentral region close to the source of an earthquake. As it is here that the worst damage usually occurs, and as the observed damage seems to vary greatly in extent even within a few tens of meters, it is difficult as yet to translate the seismic magnitude data of earthquakes observed from a distance into the criteria engineers need for designing structures which may one day find themselves at the epicenter.

In terms of human suffering, much of the damage caused by earthquakes is preventable, not so much through prediction, but mainly through the adherence to codes of practice in the location, design and construction of buildings and other works. Countries advanced in earthquake disaster prevention have such codes. In others, codes have little practical meaning if they exist at all, and life goes on fatalistically in the knowledge that one day an earthquake may happen--but then it may not; it happens so rarely within the human lifespan. So memories of past misfortunes fade, more immediate problems take precedence, and the whole thing becomes someone else's problem. But if earthquakes take fewer lives than motor cars, their effect is more disruptive. It takes just one earthquake to devastate a whole city and put the economy of a region or a country to ruin. It is the small, developing country that is most vulnerable.

Unfortunately, the most vulnerable also appear to be the least aware or, at any rate, the least active or capable in attempting to mitigate the hazards. Somehow, each country concerned must seek to assess its own earthquake risk along with the other hazards which waylay the fulfillment of its development plans. Earthquake risk is the compound of two factors: the seismicity of the region, and the vulnerability of the society to earthquake hazard. The former is largely a matter for assessment by earth scientists, while the latter is the domain of engineers, economists, politicians and planners. What is required now is for all these to work together.

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Methods for Speeding Food Relief in Disasters

Mitchel B. Wallerstein

[Minimizing the delivery time for food supplies following a disaster is a goal of many emergency assistance agencies. Use of satellite tracking systems for finding and diverting nearby ships carrying grain, computerized locator systems for these ships, and regional grain reserves are three possible approaches. The pros and cons of these methods are discussed.]

Despite recent initiatives to improve the effectiveness with which international disaster relief efforts are coordinated, most actions taken in the immediate wake of an emergency have remained largely *ad hoc* in nature. Donor countries and non-governmental organizations contribute whatever they have available at the time or can obtain at short notice. The specific concern in the present context is with the matter of food-related needs in disaster situations and whether modern technology can, in the future, play a role in speeding the delivery of appropriate commodities to the affected area.

The present study goes one step further by investigating the actual feasibility of alternative technological systems that might speed food disaster situations. The application of "technological fixes" has long held great attraction for policymakers because they offer the possibility of solutions that can be implemented relatively quickly. It is increasingly apparent, however, that such technological approaches will continue to be appropriate only as a most basic form of first aid, and that sophisticated

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technology cannot and will not obviate the need for preparedness planning or adequate attention to economic and social development. Moreover, in most crisis situations, the immediate food needs of a population can be met relatively quickly, at which point the remaining need would not be for additional foodstuffs but for other types of reconstruction assistance.

There are, in any case, at least three alternative technological approaches to the problem of the efficient channelling of food commodities to disaster zones. The first would employ the remote sensing and communications capabilities of satellites to track the actual position of grain-carrying ships at sea. With the second alternative, approximate ship positions would be plotted based on regularly updated information on course, speed, and intended destination; a number of computer software programs of this sort are already in existence. The third approach rejects the idea of diverting ships at sea and proposes instead that modest food reserves should be held in regional storage facilities in "high risk" areas and then moved directly to the disaster zone when needed.

Scope of the Problem

Before considering the question of how (or whether) to trace grain ships at sea for possible diversion in emergency situations, let us first set the matter in the context of the larger global flow of food commodities. In 1976 international trade in food grains totalled more than 77 million metric tons, almost all of which was directed to the developing world. But the actual shortfall in disaster situations for any given year is normally rather modest when compared to these volumes, and because of the extreme difficult and complexity of diverting commercial food shipments, this study will be confined only to the question of diverting flows of food grain moving as aid.

The preceding statement is meant to apply to the so-called "fast" developing emergencies such as earthquakes, floods or civil strife, and not to the so-called "creeping" emergencies such as droughts or famines which obviously require a far greater volume of food supplies over a longer term. Because of the secretive and competitive nature of international grain trade, the movement of commodities is very closely-held information. Moreover, because the U.S. grain companies rarely own the grain once it has been shipped, diverting the cargo would be much more costly and time-consuming than in the case of food aid which is owned by a government or international voluntary agency.

Finally, it may be useful to provide some sense of the size and distribution of the world merchant marine fleet and the volume of grain movements within this context. Grain is normally transported in so-called ore/bulk carriers which, in 1970, comprised less than five percent of the world shipping fleet. Due to their size, however, ore bulk carriers transport annually about 25 percent of the world's commodity trade. Grain may also be carried in converted oil tankers (when suitably cleaned and prepared), and together with the bulk carriers, this represents over 75 percent of the total carrying capacity of the world's merchant fleet.

By 1980, nearly 90 million metric tons of grain was being transported annually by ship with an average voyage length of about 5,000 miles. Table 1 provides a summary of the number of tankers and ore/bulk carriers estimated to have been to be at sea in 1980, while Table 2 indicates the number of vessels likely to be operating in each major ocean. While not all of these ships would always be carrying food grains, it nevertheless becomes apparent from this data that, unless it is possible to differentiate cargos of commercial food *trade* from cargos fo food *aid*, the number of vessels that any system would have to identify and keep track of on a daily basis will be extremely large.

Model One: Satellite Tracking Systems

The most technologically sophisticated and capital-intensive method for keeping track of the global movements of food would employ earth orbiting satellites to continuously track and communicate with

TABLE 1

ESTIMATED NUMBER OF TANKERS AND ORE/BULK CARRIERS AT SEA IN 1980 (TOTAL NUMBER OF VESSELS SHOWN IN PARENTHESIS)

Size (Gross tons)	Tankers	Ore/Bulk carriers
100+	5,559 (7,039)	3,519 (5,370)
1,000+	4,455 (5,426)	3,519 (5,370)
6,000+	3,990 (4,748)	3,519 (5,370)
10,000+	3,850 (4,533)	3,235 (4,900)

Source: Adapted from: Charles Dorian, Applications of space communications to the Maritime Mobile Service, *Telecommunication Journal* 33, 344, Table 1 (May 1971).

ships, and a central computer storage and retrieval system to update this information on a daily--or, perhaps, even hourly--basis. The scheme proposed most frequently is modelled after the one employed currently by some of the large multi-national oil companies for monitoring the movements of their tanker fleets.

TABLE 2

ESTIMATED NUMBER OF VESSELS AT SEA IN MAJOR OCEANS IN 1980

Ocean	Tankers	Ore/Bulk Carriers	Total
Atlantic	4,342	2,474	6,816
Pacific	2.229	3,930	6,159
Indian	2,529	322	2,851

Source: Adapted from: Charles Dorian, Application of space communications to the Maritime Mobile Service, Telecommunications Journal 33, 344, Table 2 (May 1971).

Each oil company operates its own transportation management system which commonly includes computerized recordkeeping on tanker departures, cargo, intended destination and routing. Vessel masters maintain contact with the home office via the MARISAT communications satellite, or through advanced ship-to-shore radio, and they usually notify the company of any en route delays exceeding 6-12 hours. Ships must also report their position at certain pre-determined geographical check points. Due to the competitive nature of the oil business, companies do not as a rule share information voluntarily on specific ship locations. However, as a result of the serious distribution problems which occurred during the 1973 Arab oil embargo, a standby emergency reporting system was created--at U.S. initiative--as part of the International Energy Agency (IEA) located in Paris.

The obvious advantages of the MARISAT system in the context of disaster relief is that it facilitates easy position tracking and rapid communication with ships anywhere at sea. It has a number of disadvantages, however. For one thing, the cost of the basic equipment and user fees are high in comparison to other available alternatives. Second, unlike the oil industry, where a large portion of the fleet is owned by the companies themselves, many different types of ships (e.g., bulk carriers, idle oil tankers, etc.) carry grain, and most operate on a charter basis. Third, many grain vessels are old and dilapidated; it is somewhat unlikely, therefore, that the owners of such vessels would be willing to invest additional capital simply in order to make use of the MARISAT system. Finally, many grain transport vessels do not carry grain exclusively, and there would be little incentive for vessel owners to agree to participate in an international system unless offered powerful incentives to do so (e.g., cost-sharing for the communications equipment or preferential treatment in the awarding of charter contracts).

Model Two: Computerized Locator Systems

A second possible method of tracking the movement of food grain shipments eliminates the satellite link entirely and reduces greatly the participation burden on shipmasters and the investment required for ship owners. As a result the capacity to continuously track vessel movements and find their location in a short time is forsaken in favor of less expensive but more comprehensive coverage.

The basis for the computer-plotted tracking system is the acquisition of regularly updated data on vessel movements, including cargo, course, speed, and intended destination. These basic variables have been factored into a number of computer software packages each having the capacity to project the likely location of a ship, with accuracy varying as a function of the currency of the data made available. Three alternative approaches were investigated for potential in the tracking of food grain shipments: (1) tying into systems operated currently by the U.S. Coast Guard and Federal Maritime Administration which are intended primarily for the purposes of search and rescue; (2) utilizing existing commercial software packages that assemble publicly available information on ship movements worldwide; and (3) expanding deployment of the techniques used by the U.S. Department of Agriculture and Agency for International Development for tracing the movement of P.L. 480 food aid commodities to the remainder of the international food aid shipments.

U.S. Government maritime tracking operations. Two agencies of the U.S. government, the Maritime Administration and the Coast Guard, currently operate programs which maintain up-to-date information on the arrivals, departures and (periodic) at-sea locations of merchant shipping, based on standardized radio reports submitted by the ship-to-shore stations. The Maritime Administration program exists essentially for keeping agencies of the Federal Government informed concerning the locations of U.S. flag or U.S.-owned vessels throughout the world, while the Coast Guard program is intended solely to facilitate at-sea search and rescue efforts for ships in distress. With slight modifications, both systems could be employed to track food grain shipments.

The fundamental attraction of an AMVER or USMER system (abbreviations for the systems used by the Coast Guard and the Maritime Administration respectively) is that it provides a relatively high degree of accuracy in position plotting without making heavy demands on ship operators. Participation in the case of USMER is, of course, mandatory, while with AMVER shipmasters and owners have the incentive of Coast Guard emergency protection. There is uncertainty, however, as to whether shipowners would be as willing to participate in the AMVER system if they were required to disclose the nature of their cargo; and, since search and rescue is the primary objective, it is logical that the Coast Guard's first priority must be to keep the participation rate as high as possible.

Commercial shipping-locator software packages. Information on merchant ship arrivals and departures is of interest to insurance agents and others, and a number of commercial publications list much of the same information recorded in AMVER. Information is assembled from ship brokers, insurance agents and local newspapers rather than shipmasters. Of greatest interest is the "Ship Movement Library", part of a Maritime Data Network, a joint venture of five companies including Lloyd's Register of Shipping and Marine Management Systems Inc. Under a worldwide computer time-sharing system one could, for a minimal fee, request by a local telephone call the names of all ships loading grain in U.S. west coast ports, for example, or of all grain-carrying ships headed toward the east coast of Central America. The data are much less up-to-date and less reliable than AMVER's, but are easily obtained at low cost.

AID/USDA food aid tracing system. The U.S. Department of Agriculture (USDA) and Agency for International Development (AID) have developed fairly sophisticated procedures for tracing the movements of cereal grains shipped for U.S. food aid. Since the U.S. contribution represents such a large portion of the total world food assistance, this centralization might (and often does) make the difference in an emergency situation.

AID officials claim that they can generate a computer print-out of ships, cargo type, and gross tonnage within the course of a single working day. Once it has been determined which ships are in a position to respond quickly and effectively, the Agency would contact one of the voluntary agencies such as CARE, Inc., or the World Food Programme, depending on who was managing the food aid, and seek permission to divert the cargo. Normally this procedure can be accomplished within 24 hours, at which point AID then contacts the ships' owners or agents, who in turn contact the ships directly. The system is sufficiently effective that, in the case of the Nicaraguan earthquake, ships reportedly were diverted at sea on the same day the disaster occurred. In the case of the 1976 Guatemalan earthquake, ships apparently were diverted within two days.

Model Three: Regional Emergency Food Grains Reserves

For financial and other reasons, obtaining the voluntary cooperation and participation of shipowners and shipmasters would be a major obstacle in all of the aforementioned alternatives except for the U.S. food aid management system. The problem is not so much that the maritime community is unwilling to be of assistance in legitimate, humanitarian situations, but simply that there are certain costs (e.g., new equipment, labor time) involved in participating in a system that requires regular position reporting and possible course deviation. In the merchant shipping industry, as in any other profit-making business, little is done solely on the basis of altruism.

It is therefore worth examining whether the basic notion of diverting ships at sea is the most feasible long-term approach to the problem of supplying adequate food in international disaster situations. It might be more cost-effective instead to establish and store modest, regional food reserves in areas of the world where the margin of resources available to deal with unforeseen emergencies is limited or non-existent. In theory, regional emergency reserves could be mobilized quickly and moved to the disaster zone. This third model would avoid the problems of tracking or diverting food grain shipments at sea, and the need to coordinate the actions of a large number of diverse, unrelated parties (i.e., ship-brokers, owners, masters, government officials, and so on).

Two principal technological approaches have been proposed for the storage of regional emergency food stocks. Neither model has, to the author's knowledge, ever been costed out fully. The first and more conventional alternative would be to construct facilities to store the food grains in a centrally located, easily accessible port in each "high risk" area in the developing world. In the event of a regional disaster or food emergency, the commodities could then be loaded onto barges and towed by ocean-going tugs either to a port near the affected area or directly inland on a navigable river.

A second alternative would be to purchase or charter idle oil tankers to be used as "floating silos" for the storage of grain in high risk areas. The most obvious advantage of this approach is that it would avoid the need for double-loading of the grain required with a land-based reserve. That is, a tanker silo could be loaded at the donor country's port, sailed across the ocean, and moored in a "semi-mothballed" status to await use in an emergency. It has also been suggested that, if the tanker silos were purchased rather than rented, the propulsion units could be removed and special automatic off-loading equipment could be installed that would make this storage method far cheaper than the construction and maintenance of land-based grain elevators.

Although either of the two alternatives proposed would avoid most of the logistical problems raised in models one and two, each would also raise an entirely new set of difficulties. First, depending on the geography of the particular region and the spatial separation of the reserve stocks, it is not clear that this model would represent a substantial time saving over the diversion of ships steaming in the vicinity. Second, both storage methods involve major, unanswered questions regarding who would pay for the storage, rotation and transportation of the grain, and who would decide under what conditions the stocks would be released. Third, there are logistical problems with both approaches: the land-based system requires double trans-shipment and expensive storage facilities; while tanker silos could be extremely expensive if chartered. The use of the tanker *Manhattan* as a floating silo for 4 months during the Bangladesh emergency, for example, cost USAID approximately $19,000 per day. Use of floating storage vessels would also have to confront the fact that large tankers are too deep of draft to be sailed or towed directly into many of the ports in developing countries, although it might be possible to circumvent this problem by designing special, shallow-draft tankers for use as silos.

Problems of Implementation

In considering the various methods for diverting grain, either in loading or already at sea, the most fundamental problem is that of obtaining the rights to the commodities. The grain companies do not monitor the movement of their commodities once the ownership papers have been passed to the buyer. Even in the case of diverting grain shipped as aid, it is necessary to re-negotiate with the ship's owners regarding extra steaming time, special insurance, special unloading costs, and perhaps even the price of the cargo itself. If a ship must enter a war zone, there may be particularly severe insurance problems. Many foreign flag vessels may, in fact, refuse entirely to be diverted under these conditions.

A second set of problems concern the draft of grain ships and the availability of deep water ports. On the average, a typical bulk carrier will transport a cargo of 25,000-40,000 tons, but one particular U.S. shipment to India actually exceeded 105,000 tons; this ship was forced to anchor nearly 5 miles off-shore for unloading. The tanker *Manhattan*, used in the Bangladesh relief operation, had to anchor with its 66,063 ton cargo fully 14 miles from the nearest land, and 56 miles or 8 hours steaming time from the main port of Chittagong. A tanker or bulk carrier may cost $10,000-20,000 per day to operate whether it is moving or anchored.

A third set of problems relates to the unloading process itself. Even if a ship is able to enter the port nearest a disaster zone, automated, high-speed off-loading equipment may not be available. This will require, therefore, that a diverted ship possess or obtain access to portable "vacuvators," mechanical devices used to suck the grain out of the hold.

Finally, there is the problem of how the grain will be moved from the vessel once it is unloaded. Particularly in the case of large ships which are unable to enter port, some form of lighter ship or barge will be required. In the case of the Bangladesh emergency, good results were obtained with the use of so-called "minibulkers," which are miniature versions of the big, ocean-going bulk carriers, designed originally for use on the Mississippi River. Between June and November 1972, these vessels unloaded more than 100,000 tons of grain per month.

Conclusions and Recommendations

Food relief in disaster situations is, in reality, a two stage process. There are, first, the immediate post-crisis food requirements, which may only be met with reserve supplies on hand or through the use of air-cargo planes; and second, there are also the continuing food needs of the affected population which must be attended to until normal production and distribution channels can be re-established. Since the three approaches considered here have little or no application to the former situation, it may be concluded that the technologies designed to track actual ship positions using satellite remote sensing (i.e., Model One) are more sophisticated and, therefore, more expensive than is warranted for the purposes of longer term post-disaster food supply. Moreover, large scale international disasters fortunately do not occur with great enough frequency to justify either the investment in or the deployment of such a system.

On this basis, some variation of Model Two, the computerized locator system, would seem much more appropriate than Model One to the problem at hand. Since there does not appear to be any overriding need to track the position of grain shipments at all times, it would seem that any system capable of plotting reliably the approximate position of all grain carrying vessels in a particular geographic region would be satisfactory. The question then becomes one of the degree of reporting accuracy relative to the level of cooperation and participation required of ship owners and operators. It stands to reason that the system (or systems) requiring the least inconvenience to the maritime community, while still generating accurate data on ship positioning, would be the most likely to succeed.

The computer software packages currently maintained by Marine Management Systems, Inc. and by AID would appear to meet these criteria. Both systems have certain advantages: the Marine Data Network offers the more current reporting and also facilitates easy global access through an international computer time-sharing system; the AID food aid management system, on the other hand, is already geared to tracking the specific movement of U.S. food aid commodities. It is possible that a synthesis of the two approaches (i.e., one which encompassed the food aid offered by other bilateral donors as well) might represent the most feasible short range solution, offering the capability of locating and diverting ships at sea within a 24-48 hour period.

In the longer term (5-10 years), a better coordinated system of food tracing could be augmented profitably by the creation of a limited number of regional emergency food reserve stocks. Based on the information currently available, it would appear that a more conventional land-based storage facility, employing barges or minibulkers to move the food grain, would be the most practical alternative. Such a system could be integrated with the International Emergency Reserve program administered by the WFP, thereby permitting multilateral sharing of the costs associated with maintaining reserve stocks. In fact, since only a limited number of donor countries are normally in a position to provide the actual commodities for a physical reserves stock, it might be particularly appropriate for the other, non-food-exporting developed countries to supply the capital needed to pay for storage, maintenance and transport of food reserves.

A word about implementation is also in order. While the majority of physical problems may be overcome through intelligent design of the system that recognizes the constraints at hand (e.g., port capacity and so on), institutional difficulties are less amenable to change. It would seem that, in terms of present responsibilities and expertise, the UN-FAO World Food Program is the logical focal point. This alternative is made all the more attractive by the apparent willingness of AID to share its technical expertise in the development of an international food tracing system. The WFP represents the most logical organizational framework within which to operate a computerized locating system in order to encourage contributions by all the donor countries--not just the U.S. Finally, in the longer term, expansion of the present WFP International Emergency Reserve to include a modest, tangible supply of regionally-based emergency food stocks could remove the need for at-sea diversions of food grain shipments in all but the most extraordinary of circumstances.

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CONTENTS

Volume XIX, Number 3 July, 1981

FARMER-CENTERED RESEARCH

A LESSON FOR RURAL DEVELOPERS: THE SMALL FARMER IS A PROFESSIONAL 3
Robert Chambers

AIMING AGRICULTURAL RESEARCH AT THE NEEDS OF FARMERS 13
Donald Winkelmann and Edgardo Moscardi

AGRICULTURAL PRICING POLICY

AGRICULTURAL PRICING POLICIES IN DEVELOPING COUNTRIES 25
Gilbert T. Brown

AGRICULTURAL PRICE MANAGEMENT IN EGYPT 37
William Cuddihy

PUBLIC RICE DISTRIBUTION AND WELFARE IN SRI LANKA 46
James Gavan and Indrani Sri Chandrasekara

ENERGY CHOICES

ENERGY SOURCES AND TECHNOLOGIES: HARD CHOICES 57
R. Thomas Hoffmann and Brian Johnson

WOOD AS FUEL 71
U.S. National Academy of Sciences-National Research Council

STOVE DESIGN FOR EFFICIENT WOOD BURNING 82
U.S. National Academy of Sciences-National Research Council, and Volunteers in Technical Assistance (VITA)

ENERGY CHOICES (cont'd)

PEAT AS AN ENERGY SOURCE 91
D. V. Punwani

CULTURAL AND EQUITY CONSTRAINTS CONDITIONING ENERGY USAGE 98
Elizabeth Cecelski, Joy Dunkerley and William Ramsay

AID STRATEGY

GROWTH, POVERTY ALLEVIATION AND FOREIGN ASSISTANCE 109
Michael Crosswell

EDITORIAL COMMENT: SOME TRENDS IN THINKING ABOUT DEVELOPMENT IN THE 1970s AS REFLECTED IN THE DEVELOPMENT DIGEST 125
Gordon Donald

Money values will be expressed in U.S. dollars unless otherwise specified. The spelling "tonne" will be used to indicate metric tonnes (1000 kilograms), and "ton" will refer to traditional U.K.-U.S. tons (2000 lbs. or 2400 lbs.).

FARMER-CENTERED RESEARCH

SMALL FARMER PLOWING IN THE
ANDES MOUNTAINS IN ECUADOR
(PHOTO: FAO BY P. BOTTS)

A Lesson for Rural Developers: The Small Farmer is a Professional

Robert Chambers

[Unconscious biases exist in the opinions and advice of "professionals" of every kind working on rural development in the developing world. These biases often render programs ineffective. The most difficult thing for an educated expert to accept is that poor farmers may often understand their situations better than he does. The following article examines some of the common biases and sets forth some remedies to aid in overcoming them.]

Self-critical introspection is not a prominent activity in professions concerned with rural development. It can be argued, though, that without such introspection our views of small farmers and their environments are likely to be largely determined by our professional training, the forms of exposure we have to small farmers, and our own environments. We are taught to see the world in certain ways, to look for certain things, to ask certain types of questions. This makes it difficult for us to see the world in other ways, to look for other things, and to ask other types of questions. A medical doctor, an agronomist, an engineer, an economist and a sociologist, visiting the same village, will see and inquire about very different things. They will gain very different, and partial, views of a whole that is seen differently, and more holistically, by the villagers themselves. They will reach different, and sometimes conflicting, opinions about what ought to be done in the name of development.

A first step, then, in trying to understand small farmers and their environments is to become aware that we have professional blinders: that there are things

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we do not see, questions we do not ask, and relationships we do not identify. We also have to understand the biases built into the ways in which we are exposed to and carry out inquiries about small farmers and their environments.

Rural development "tourism" (brief rural visits by urban-based professionals) is a very widespread activity. It has interlocking and mutually reinforcing tendencies that direct attention to those who are better off, to the exclusion of those who are worse off. Rural development tourism has many biases:

- *urban:* toward those rural areas near towns. These are usually more prosperous
- *pavement and roadside:* along paved roads, where the better-off people live with the better services
- *regional:* to regions that are more developed rather than less
- *project:* to projects rather than areas without projects
- *elite and large farmer:* toward meeting those who are better off and more powerful, toward the larger and more progressive farmers, and toward farmers rather than the landless
- *male:* toward meeting men rather than women
- *user:* toward meeting users rather than non-users of services (the members of cooperatives, not non-members, etc.)
- *dry season:* toward travel in the dry season after harvest when people are healthier and better fed, rather than during the rains before harvest when the reverse is true
- *irrigation:* toward areas with irrigation rather than those without; and so on.

Any one of these on its own would be serious. Combined they mean that there is a strong systematic bias toward perceiving rural people as being more prosperous and less deprived than they really are, and toward interacting with and learning from those who are better off rather than those who are poorer.

Moreover, the rewards, prestige and promotions in professions face inward, as it were, toward urban and metropolitan centers.

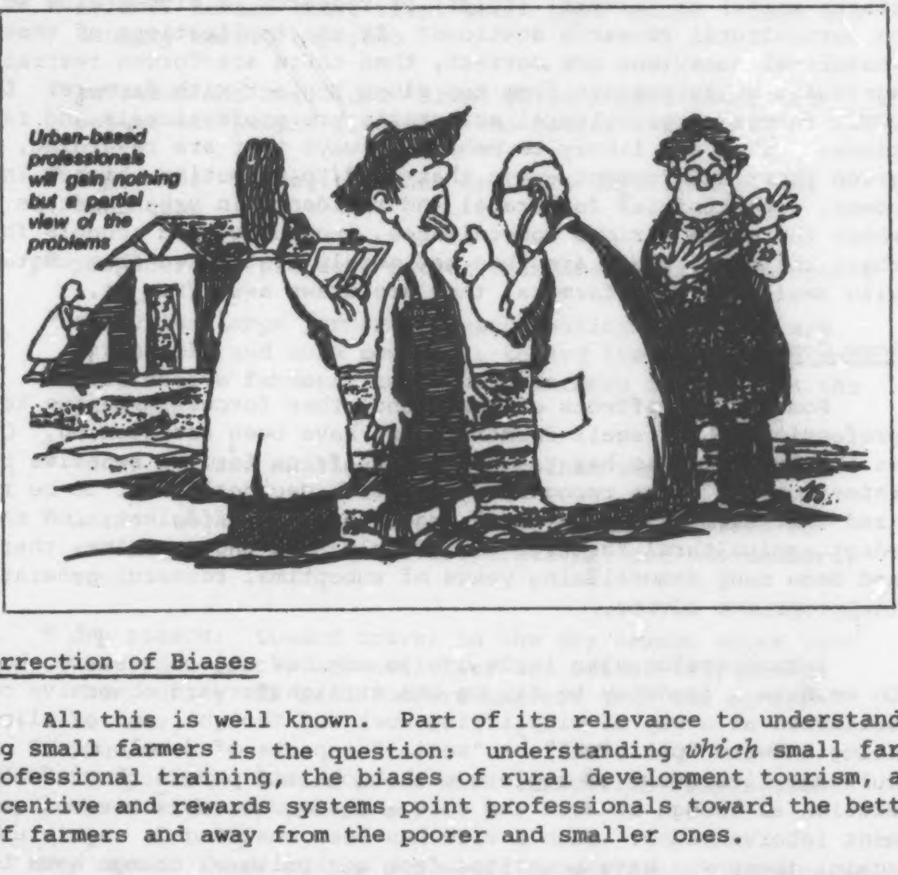
One can ask: which is valued and rewarded more, professionally--research that benefits small and poor farmers more but generates fewer publications, or research that generates more publications but benefits farmers less? Research on crops or animals for the market or for export (coffee, jute, tea or exotic cattle), or on low-status, more subsistence crops or animals (millet, goats, hens, for example), which are important for the poorer people? Work that makes use of indigenous technical knowledge and is carried out in collaboration with farmers as equal colleagues, or work that is based solely on modern scientific knowledge regardless of the on-farm situation and without farmers' participation? Trials (a low-status word?) on farmers' fields, or research (a high-status word?) on agricultural research stations? If the implications of these rhetorical questions are correct, then there are forces restraining agricultural scientists from too close contact with farmers. Like small farmers, agricultural scientists are professionals and rational. They are likely to behave in ways that are rewarding, given their environment--ways that lead to promotion, higher incomes, opportunities for travel and residence in urban centers where there are various conveniences, including good schools for their children. They are then not merely restrained from contact with small and poor farmers; they are drawn away from it.

Some Consequences

Some of the effects of these and other forces that have kept professionals and small farmers apart have been astonishing. One is the long time it has taken in East Africa for the benefits of intercropping to be recognized. It took decades for it to be realized that farmers' "primitive" practices were efficient, and to adapt agricultural research accordingly. In the meantime, there had been many demoralizing years of suboptimal research generating inappropriate advice.

Introspection also leads one to ask how objectives are chosen. Do we have a tendency to fix on one straightforward objective or criterion as a way of simplifying work and thought, and of eliminating awkward "political" or "social" aspects of development? Agricultural literature is replete with books and papers that treat production as though it were the sole and adequate objective of government interventions. Such a view has been challenged: again and again, those who have benefited from agricultural change have been the strong, the powerful, those who were already better off. The poor and less powerful have sometimes gained a little, sometimes gained not at all, and sometimes lost.

Whatever the myths, agricultural research is highly political in its implications, since it affects who gets what in society. Unless approaches to research deliberately incorporate equity considerations, the familiar pattern will be repeated. But agricultural scientists may protest that this is none of their business. In the words of the Tom Lehrer song ". . . when the rockets go up, who cares where they come down--that's not my department . . ." And yet, to pursue the metaphor, the choices about what sorts of rockets to build (what sorts of research to carry out) do determine where they are likely to come down--who will gain and who may lose. Research on poor people's food crops will benefit different groups of farmers more than research on a cash crop grown only by the larger farmers, or only by those with irrigation.


Urban-based professionals will gain nothing but a partial view of the problems

Correction of Biases

All this is well known. Part of its relevance to understanding small farmers is the question: understanding *which* small farmers? Professional training, the biases of rural development tourism, and incentive and rewards systems point professionals toward the better-off farmers and away from the poorer and smaller ones.

If agricultural research is to achieve optimal trade-offs between equity and production objectives, then the following reversals appear necessary.

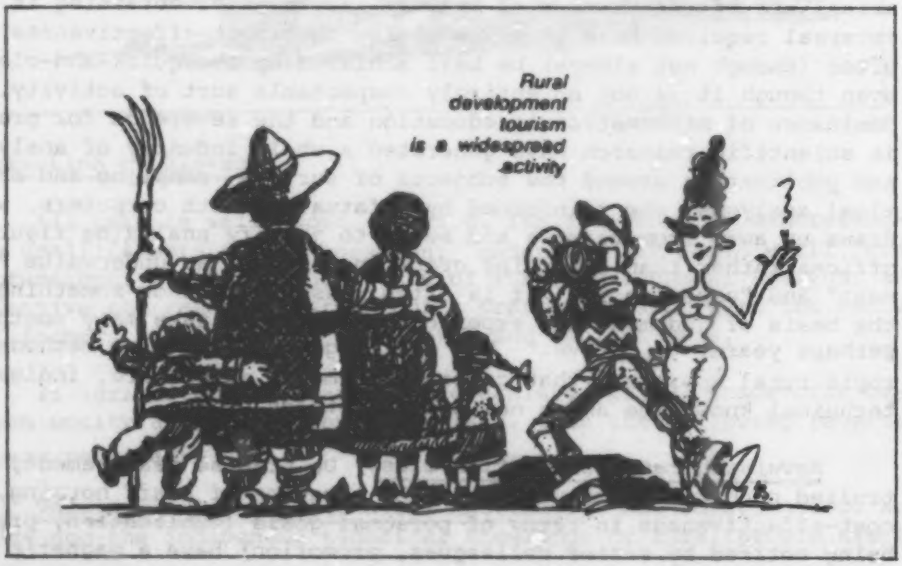
Valuing indigenous technical knowledge. Modern scientific knowledge and the indigenous technical knowledge of rural people are grotesquely unequal in leverage. The former is centralized, and associated with the power and machinery of the state; and those who are its bearers believe in its superiority. The latter, in contrast, is scattered and associated with low-prestige rural life; those who are its bearers may believe it to be inferior. It is difficult for some professionals to accept that they have anything to learn from rural people, or to recognize that there is a parallel system of knowledge to their own which is complementary, that it is usually valid and in some respects superior. The ability of the Hanunoo people in the Philippines on average to name 1,600 plant varieties, 400 more than in a botanical survey, illustrates the point. Rural people often have their own categories and fine discriminations; they often have much detailed knowledge of soils, of plant indicators of fertility, of weather patterns, of pests and weeds, and the like. Unfortunately, many of those who are bearers of modern scientific knowledge have been trained away from being able to learn these different ways of seeing the environment, or to understand the problems and rationality of small farmers. They do not realize that small farmers are professionals too. The challenge is to be able to learn from them, as colleagues.

Quick-and-clean versus long-and-dirty. Rural appraisal has tended to have two polar forms--the casual empiricism of rural development tourism, and the long-drawn-out and extensive rural survey. The former has been described as "quick-and-dirty;" and the latter might be described as often "long-and-dirty." The need is to develop methods that are "quick-and-clean," where clean means cost-effective in terms of trade-offs between quantity, accuracy, relevance and actual use of information as against the costs of obtaining it. The reversal required here involves seeing that cost-effectiveness may often (though not always) be best achieved by the quick-and-clean, even though it is not an entirely respectable sort of activity. The dominance of mathematics in education and the reverence for precision in scientific research have generated a whole industry of analysis and publication around the subjects of surveys, sampling and statistical analysis, now reinforced by infatuation with computers, which draws us away from farmers and seems to justify analyzing figures in offices rather than observing crops in fields. We undervalue "judgment" and "experience." It is often possible to know something on the basis of judgment and experience that would take many months, perhaps years, to "prove." The challenge is to develop methods for rapid rural appraisal that combine judgment, experience, indigenous technical knowledge and a new set of methods.

Reversing research station bias. Do precise measurement, controlled conditions, convenience, the location of staff housing, and cost-effectiveness in terms of personal goals (publication, prestige, being noticed by senior colleagues, promotion) have a magnetic effect in holding agricultural scientists on research stations? For some forms of agricultural research and development there is a valid case for conducting work only under controlled conditions. But these controlled conditions are artificial; they leave out farmers' needs, resources, and problems.

Controlled conditions only are in this sense peculiar and incomplete. Leaving out farmers is a heroic simplification of the environment. Given the many attractions of working on research stations rather than with farmers, one may ask whether there may not be a tendency to rationalize the desirability of on-station work. If the criterion of good research is beneficial impact--benefits to farmers and others in terms of production and equity--might it not be cost-effective for much more work to be conducted with farmers in farmers' conditions?

These three reversals--learning from farmers, using rapid and approximate methods and offsetting research station bias--are reflected in recent work by Michael Collinson with Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT) in East Africa and Peter Hildebrand with Instituto de Ciencia y Tecnología Agrícolas (ICTA) Guatemala. Collinson has been shortening the period of survey required to identify research priorities. Hildebrand has developed an ingenious method for rapid appraisal combining agricultural and social scientists in investigating farming situations and leading straight into innovations that are then tested with farmers on their fields.



Unfortunately, there is a tendency for those who engage in and develop these new approaches not to write them up in full detail. It is only in the past few years that describing exploratory or reconnaissance surveys, and quick-and-dirty or quick-and-clean methods, has become a half-respectable activity. It is now, or should be, more than respectable: for these activities are at the frontier of important developments leading to greater cost-effectiveness in agricultural research.

Much of the argument concerns changes in professional values and behavior. But we are faced with a complex system with many interlocking parts--the dominant influence of the agricultural professions in industrialized countries, the policies of editors of journals, urban and research station bias, the curricula of university courses, ideas about respectable and rigorous research methods, disciplinary blinders, belief in the universal superiority of modern scientific knowledge over indigenous technical knowledge, and so on. Combined, these various forces direct attention and effort away from small farmers, away from learning from them and with them, toward the citadels of professional advancement and toward inappropriate research.

Implementing Change

In seeking to change this, some of the obstacles are cognitive. The problem is often the way in which people have been conditioned to perceive and interpret experience. It is difficult enough for a sociologist, for example, to learn to think like an agronomist, let alone for either of them to learn to think like a small farmer. And yet seeing the world in the other person's way--whether the view of another discipline or the multidisciplinary view of small farmers--requires a difficult combination of openness, imagination and humility. Our status and self-esteem are often built on the premise that we have superior knowledge. It then becomes important in public situations for us to display that knowledge, and for the knowledge to be indeed superior.

A recent report listed among the competencies required in young professionals for agricultural research and development, "Ability to handle farming skills *confidently* in front of farmers." This conjures up precisely the problem of the presentation of one's self in such situations: it may be more important to have the greater confidence required to admit ignorance. But even that does not go far enough, for it treats ignorance as something shameful. Rather, ignorance should be accepted positively as an opportunity to learn, whether from another discipline or from small farmers.

The practical problem is how to achieve such an attitude, and the cognitive changes that result. For social and agricultural scientists concerned with small farmers, four suggestions can be made.

1. Joint field work with professionals in other disciplines. This is a key part of the Hildebrand and CIMMYT approaches. It is fascinating and illuminating to work in field situations with people from other disciplines. One is continuously surprised and intrigued by the things they see, the questions they ask and the inferences they draw. There are few better learning experiences. Numbers should, however, be kept small. For short periods, two people may be ideal. Such work might be a required part of university education and of subsequent specialized training. It should certainly be a crucial part of agricultural research for defined area projects, not just as a learning experience but also in its own right as a means to effective work.

2. Required learning from small farmers. Professional and career development in all fields typically involves periods of further training. In India, for example, this has been organized for senior agricultural experts and administrators. One activity might be investigation of the knowledge of small farmers. For example, glossaries of local terms can be compiled. Among some pastoralists, a listing of words for colors would show a series of very fine discriminations, especially in the browns, which are not captured in other languages. More directly relevant are investigations of names for plants, soils and plant indicators of fertility and microclimates. Farmers' categories, related to their experience and needs, differ from those of scientists, and not only in the Third World: recent work at Cornell has shown that farmers in up-state New York do not find the soil classification of the U.S. Department of Agriculture helpful, and use their own names for soil types. Another example is the calendar system of Bihari farmers in India, which has been found to be more appropriate for describing changes in climate and the sequences of cultivation than the months of the more usual calendar.

One promising approach to learning how small farmers (and professionals) construe their environment is the triads test. This has been used independently by Paul Richards in Sierra Leone with weeds, and by Stuart Hawkins in Australia with dairy sheds. Richards used it to elicit the way in which university botany and geography students, farmers and trainee extension workers saw weeds. In the test or game, four weeds were taken, and respondents presented with groups of three, asked to identify which two were most similar, and then asked to explain the "construct" underlying their choice. This was repeated for different combinations of threes until the latter were exhausted. The university students' construct were taxonomic and morphological. There was no overlap with the farmers' constructs, which were utilitarian. The most startling finding was that the extension trainees' constructs were close to those of the students and also did not overlap with those of the farmers. The test was enjoyed by the participants, and led to a spontaneous 'seminar' by the trainees on how they would communicate with farmers if their 'scientific' approach to farming made them think in textbook botanical terms rather than in terms of farming utilities. Tentative action proposals for syllabus development and for studying alongside the farmers were beginning to emerge at the end of the period.

Perhaps learning from farmers, using the triads test, might be tried out to see whether it could be a suitable part of future professional training. To require professional staff to learn from farmers in these ways should not be considered demeaning or threatening. On the contrary, it is inherently fascinating to try to understand how other people construe the world. Moreover, where "games" are involved--as with the triads test--the activity is enjoyable as well as intellectually exciting.

3. Learning through games. A further approach is to play specially devised games. Some "green revolution games" have been developed. In these, each player starts with similar resources (finance, family labor, land, water) and makes farming decisions, season by season, in the face of uncertainty about weather, input supply, pests, diseases and the like. A simple computer program, with coefficients derived from actual small-farmer situations and incorporating random contingencies, then presents the outcomes of the decisions. Over a period, players become differentiated: some become wealthy, others landless. But in the process, they are forced to think like small farmers, and to understand their rationality, for example in risk aversion. Such games could become a required part of every course for those, of whatever discipline, who are concerned with agriculture and rural development.

4. Learning by doing. The suggestion likely to be least acceptable to established professionals is that we should go and work at farm tasks with farmers in their fields. To some, this would be totally unacceptable, an affront to dignity. To others, it may appear quite a good idea, but not implementable. To a few, it may commend itself as something to be quietly tried out. And there are some who have done it already. The value of this activity is not to discover the extent to which one's muscles have atrophied, but rather to provide an opportunity for insights and learning. John Hatch's work in Peru is testimony to this. He worked for farmers without pay on condition that they would teach him the task they wanted done.

"The scheme worked beautifully," he reported. "Most small farmers took to their role as teacher very conscientiously. Rather than waiting to respond to my questions, they often volunteered task information I would never have known enough to inquire about. In fact, most of the information I gathered was gained in this way. Hired laborers often proved excellent instructors as well."

It may be objected that for professionals to work with farmers in their fields would be a waste of time. That is a matter for judgment. Given, however, that Hatch came to the remarkable conclusion that total labor use might be 50 percent higher than that estimated by outsiders, one may ask whether some professionals can afford not to use this approach some of the time. At least there is a case for gaining more experience with it, its costs and benefits, and especially the insights to which it leads.

New Professional Values

The thrust of this article is toward changes in values and behavior: to value learning from and with other disciplines, and especially from and with small farmers; to value equity as well as production; to seek out experiences that are cost-effective, if unconventional, in identifying research priorities; to conduct more research with farmers. It is easier to sit in a room in a rich country and write a little paper about this and the tough things other people should do than it is to be those other people and to do those things.

Perhaps agricultural research that is moving closer to small farmers through defined area projects presents an unusual opportunity. The value systems in agricultural research are international. In the past, this may often have exercised a conservative and inappropriate influence--toward the needs of temperate climates, toward capital intensity, and so on--and much of this may still be enshrined in the curricula of universities all over the world and perpetuated through their graduates. But that same international system could also help to create and invest with prestige a different climate of values, so that national researchers would have more freedom to adopt new practices and turn inappropriate professional values around. If this could occur, some of the beneficiaries would be those national researchers who were at the forefront of pioneering the new methods; but the largest group of beneficiaries should be small farmers whose interests would then be more directly and better served by agricultural research.

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Aiming Agricultural Research at The Needs of Farmers

Donald Winkelmann and Edgardo Moscardi

[Developing the most appropriate technology for the farmers who will use it and offering the most workable recommendations require careful consideration and research on the part of agricultural professionals. The following article proposes a set of procedures a developing country can follow to find widely useful solutions for representative farmers.]

The Problem

Few farmers in developing countries are following the recommendations of researchers and extension workers. Some claim that farmers are at fault, arguing that preferences based on traditionalism lead farmers to reject unfamiliar technologies. Some point to extension, arguing that the utility of improved technologies has not been demonstrated to the farmers. Others claim that inadequate credit limits farmers' ability to adopt improved technologies. Some emphasize that inputs are not available in a timely way at appropriate prices. Finally, but less frequently, some contend that recommended technologies are often not appropriate for farmers.

Certainly each of these explanations has been valid for some time and place. However, a number of recent experiences have shown that even the poorest farmers--presumably among the most tradition-bound and usually among those with least access to inputs, information and markets--take up certain new technologies while rejecting others. These experiences sug-

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gest that more attention should be given to the adequacy of recommended technologies. This, in turn, implies that more attention be given to the research systems which develop technologies.

In 1974 CIMMYT (Centro Internacional de Mejoramiento de Maíz y Trigo) initiated its work to identify effective procedures for developing technologies. The following discussion is based on our interpretation of experiences in this program. The procedures which have emerged are now being tried in several national maize and wheat programs. They emphasize identifying the production problems of representative farmers, and integrating the critical dimensions of their decision-making into research on new technologies. This concentration on research does not imply that the other issues mentioned earlier are not important; they are. But research is CIMMYT's chief activity.

Characteristics of Useful Technologies

The utility of technologies can be judged from two related perspectives: that of the farmers, and that of the larger society. In most cases, to be satisfactory from society's standpoint, technologies must be judged useful by farmers.

In most developing countries, choices among alternative technologies are left to farmers. Two related impressions about farmers are widely held: (1) Farmers are purposeful in their behavior, seeking to obtain incomes and to avoid risks; they are sensitive to the nuances of their environment; and they are reasonably efficient in managing the resources at their disposal. (2) While farmers' choices among alternative technologies are influenced by a host of variables, it is biological and economic forces that dominate those choices. Based on a series of CIMMYT-sponsored country studies examining factors influencing the adoption of new maize and wheat technologies (essentially improved varieties and higher rates of fertilization) we concluded that:

> ". . . the most persuasive explanation of why some farmers don't adopt new varieties and fertilizer while others do is that the expected increase in yield for some farmers is small or nil, while for others it is significant, due to differences (sometimes subtle) in soils, climate, water availability or other biological factors."

These studies and a reading of the studies done by others led to the conclusion that, while other variables might have a limited influence on choices among alternative technologies, income and risk are prominent farmer concerns; and these variables are strongly influenced by the natural and economic circumstances of the particular farmers making the choices. Hence, our emphasis is on these factors.

With this view of farmers, technologies which will be widely used must be consistent with farmers' natural and economic circumstances, and must promise improved incomes while keeping risks within reasonable bounds. Technologies which do not meet these standards will not be widely adopted.

The utility of technologies can also be judged from the standpoint of a nation's goals. National decision makers will want patterns of adoption to have consequences, e.g. for income distribution among producers or for the distribution of benefits among consumers, which are in accord with national goals. Given this concern, those responsible for national policy should not be indifferent toward alternative technologies and, consequently, toward alternative lines of research aimed at forging improved technologies.

Methods for Developing Useful Technologies

Orientation. Four points should be made before initiating a brief description of our procedures for developing useful technologies:

1. We are concentrating on that research whose results are intended for near or intermediate term application, e.g. fertilizer research or plant breeding. We are less concerned with basic or exploratory research destined to be applicable in the long run.

2. The entire process features collaborative research among biological scientists and economists. With farmers sensitive to both natural and economic forces, the formulation of technologies requires the same sensitivity. This is not commonly found in a single scientific discipline and even less in a single individual. In the partnership we envision, the biological scientist contributes his knowledge of the interaction among plants, insects, and diseases and their environment, while the economist brings an awareness of the influence on farmer decision-making of other opportunities for employing his resources and of markets for products and inputs. Beyond this, for issues relevant to policy makers, biological scientists have clearer perceptions of what is feasible through research, while economists have the advantage in sorting out the implications of the adoption of alternative technologies. Each, then, contributes elements which are crucial in the formulation of technologies consistent with the needs of representative farmers and with national goals. This collaboration is a hallmark of the procedures being described.

3. We are concerned here with formulating technologies for a single crop, or for that crop as part of a mixture. We are not discussing full-scale farming systems research.

4. The procedures aim at useful but not necessarily "optimal" technologies. After all, if each farmer responds to his own natural and economic circumstances then, as these differ among farmers, each could need a different "optimum" technology. Satisfying all such demands is clearly beyond the capacity of any national research system. In place of "optimums" we seek to forge good approximations, technologies which promise more incomes with acceptable risks to representative farmers. We expect that, after adoption, each farmer will adjust the recommended practices to fit his own particular circumstances. This expectation is entirely consistent with experience, e.g. the increasing use of fertilizer on HYV (high yielding variety) wheats in India's Punjab and in Mexico's Yaqui Valley. Moreover, this stance relieves the researcher of the costly impression that he must be precise in *framing* recommendations. The researcher must be precise in his research, of course, but his recommendations are most useful when formulated as good approximations for a large number of potential users.

In brief, then, the procedures rest on collaborative research destined for early application, treat a single crop or mixture, and promise useful but not necessarily "optimal" technologies. There is an additional caveat. We recognize that the effectiveness of agricultural research is limited by shortages of physical and human capital, by nettlesome work rules, and by other constraints as well as by the limitations mentioned in our introduction. Even so, research is being done, technologies are being recommended, and farmers are following some recommendations but rejecting most. Hence, it is appropriate to question the methods used in ongoing applied research, and to explore new formats for its undertaking.

Integrating entities. A distinguishing feature of the process described in the following paragraphs is its emphasis on representative farmers as its primary clients. In our view, this represents a significant shift for many countries in the orientation of their agricultural research. And what are the dimensions of this shift?

Much agricultural research in developing countries is concentrated on problems emphasized by professional disciplines and guided by their standards. This is entirely consistent with the training of most active agricultural researchers and with the incentives which orient their efforts. It is also consistent with the precedents followed in developed countries where technological change has contributed to rapid increases in yields and reductions in production costs. Why, then, with the system featuring professional peers as primary clients apparently working so well in developed countries, is there a shift in emphasis to farmers as primary clients?

We believe such a change will make agricultural research in *developing* countries even more effective. This conviction emerges from our interpretation of the process which links research to practice in *developed* countries. What is most emphasized in the usual statements on this process is the research of the publicly supported institutions. What is emphasized too little is the important role of entities which mediate between this research and the farmer, which integrate research results into effective technologies for farmers. In some cases the mediators are private agribusiness companies, in others public organizations; usually there is a complex of different types.

These mediating entities are not well established in developing countries. Moreover, the incentives of developing-country public institutions do not encourage the researcher to play an integrative role. On the contrary, incentives tend to accent professional contributions--measured by the timely and lucid publication of research results, the contribution to professional organizations, and the training of others in the litany of the discipline. Furthermore, work rules seemingly conspire against anything done off experiment stations. The result is that research is often more attuned to the problems of the profession than to those of representative farmers, and the resulting recommendations are often irrelevant to their needs. It is the absence of this critical integrating activity which underlies our belief that there is scope for making research systems more effective.

Recommended Procedures

We turn now to a brief description of the procedures we have been developing. Their function is to orient the competence of researchers towards the needs of farmers, bridging the gap between research and practice.

Identifying relevant farmers. Natural circumstances in most countries are usually sufficiently variable that several technologies will be needed for a given crop or crop mixture. Moreover, even farmers operating under essentially uniform natural circumstances

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might well confront such differing economic circumstances as to need different technologies for a given crop. But it is unlikely that the research resources of a small developing country are sufficient to meet all such demands simultaneously, even for a single crop. The first step, then, in organizing research is to identify the farmers for whom technologies are to be formulated.

The process is expeditiously handled by grouping environments with similar ecologies. This insures that the crop or mixture in question reacts roughly in the same way and confronts roughly the same challenges in all parts of a particular environment, but behaves differently in important ways in other environments. A first grouping can usually be done on the basis of the experience of informed biological scientists and economists working with secondary data on area, yield, soils, weather, elevations, and demography; all this should be complemented by the observations of merchants specializing in the crop.

The next step is to roughly characterize the environments in terms of information which may be important to agricultural policy, e.g. area in the crop, production levels, number of farmers, distribution of farm size, relative importance of the crop, exportable surpluses. Combing this information with researchers' impressions of the potential for improving technologies is usually sufficient to permit a first rough ordering of the environments in terms of national goals.

In Ecuador this procedure was followed to identify five environments in which farmers produce maize. It was inferred from policy statements that the government was accenting the incomes of low-income farmers. For each environment the area in maize, maize as a proportion of total cropland, average farm size and yields were estimated. The zone with the smallest farms and the heaviest reliance on maize also had one of the largest areas in maize, and biological scientists ranked it high in terms of the potential for establishing improved technologies. This congruence will not always occur, so the rankings will often have a degree of arbitrariness, becoming even more arbitrary as government goals are less clearly stated and as impressions about research potential are more probabilistic.

Identifying farmers' circumstances. While secondary data are adequate to frame general impressions, they are rarely sufficiently detailed to orient research on improved technology. Such detail requires first-hand knowledge of circumstances and problems. We advocate two related sets of activities for acquiring that first-hand information. Given the scarcity of research resources, these are concentrated on the environments assigned the highest priorities.

The first of the activities is exploratory survey work in the environments for which technology is to be developed. This will include informal but organized discussions with farmers, merchants and others familiar with the environment. The effort involves both discussion and observation, and focuses on production practices and problems, markets for production and inputs, and important competing activities. Secondary data, the knowledge of researchers, and the results of the exploratory survey are then combined to describe tentative recommendation "domains" (i.e. sets of farmers whose natural and economic circumstances are sufficiently similar so that a given technology would be relevant to each farmer within a domain.)

The second activity starts with the same sources of information plus the insights derived from the exploratory survey, then proceeding to a formal survey. The information and insights are integrated into questionnaires, which are then administered to a random sample of farmers from each tentative recommendation domain. While each questionnaire is focused on issues critical to the farmer, the farm and to the crop or crop mixture of primary concern, it also includes other activities--other crops, livestock, non-agricultural activities or non-farm activities--which impinge in important ways on the crop or mixture under study.

These surveys, especially the formal survey, serve to identify characteristics of representative farmers, e.g. farm size, common implements, typical rotations, critical periods, and access to inputs. They permit description of practices currently employed--levels, types and dates associated with each activity--by representative farmers. They provide information for establishing the representative farmer's perception of major problems affecting the crop or mixture under study. Finally, the survey data also allow for refinement of the description of recommendation domains.

The procedure starts, then, by grouping farmers into essentially homogeneous natural environments. It then orders these environments in terms of national goals, assesses farmers' circumstances, establishes groups of farmers in terms of natural and economic characteristics and of national goals, and makes specific the circumstances of representative farmers for each important crop.

Returning to the example of Ecuador, surveys there indicated that the environment assigned the highest priority contained three different sets of farmers based on natural factors. The three emerged from insect patterns and access to irrigation. The insect patterns, in turn, were closely related to altitude. Some differences in economic circumstances appeared, e.g. farm size and access to inputs; for virtually all farmers in each group, however, these differences were slight. The remaining ungrouped farmers were few and small in proportion to the total area given over to maize. So, no additional recommendation domains were formed because of economic circumstances. For each domain the survey data were used to characterize the circumstances of the representative farmer.

While data on farmer circumstances are gathered primarily to orient research, experience shows that an immediate sifting of the information for policy implications might also be profitable. For example, one maize study showed that a supposedly effective system for distributing inputs was falling far short of meeting farmer requirements for insecticides. The problem uncovered, policy makers could move to clear it up.

The perceptions of farmers and merchants, the knowledge of scientists and the information derived from surveys are then combined to reveal factors significantly limiting the production of representative farmers. As with the earlier activities, data analysis requires the joint participation of biological scientists and economists. The research itself is undertaken on experiment stations and on the fields of representative farmers.

Organizing experimentation. Some of the limitations identified will require research under carefully controlled conditions. This is usually best done on experiment stations. Its benefits often will not be realized in the near term and its results must be tested under the conditions of relevant representative farmers.

Survey work in one Andean region of Peru showed the importance of leaf diseases in maize. With the importance of the disease established, maize breeders began to screen their own plant material and sought promising materials from others to screen for resistance to this disease. In another Andean region, survey work uncovered a farmer demand for a shorter-season variety with good stalk strength. Maize breeders are now recombining shorter-season plants with those having good stalk strength and proper grain type. And why good stalk strength? Because surveys disclosed that the representative farmer grows climbing beans with his maize, and short season varieties were unable to carry the weight of the beans. These problems and opportunities were uncovered through on-farm research involving surveys and experimentation.

On-farm experimentation. The on-farm trials are initiated with "best-bet" strategies based on the experience of researchers and farmers' perceptions. At each critical period in the life of the crop or mixture, farmers and researchers come together around the crop to assess the adequacy of the strategies. Information from the trials flows to the experiment station, signaling new problems, and to trials in succeeding years. Each year information from experiment station trials is assessed for its relevance to the problems judged most critical.

Three classes of on-farm trials are advocated: yes-no trials, how-much trials, and verification trials. The yes-no trials are designed to look at major effects and first order interactions of the factors thought to be most critical in limiting production. Factorial designs are the mainstay of these trials and these feature two levels of the inputs or practices being examined, one at current farmer levels and the other at a significantly higher level. The how-much trials are designed to identify levels at which income-seeking, risk-averting farmers might want to employ inputs or practices detected as limiting in the yes-no trials.

In developing improved technologies there are always questions regarding how many factors can be changed at one time, to what degree input use can be changed, and at what level those factors not being changed should be set. For on-farm experiments, attention should be concentrated on only three or four factors at a time. Most evidence indicates that farmers tend to make only a few changes at a time, concentrating on those with the highest payoffs; so research can be concentrated on a limited number of factors rather than aiming at all potential changes in one fell swoop. Regarding the levels of input use, profit and risk considerations require that rates of return on purchased inputs be quite high, i.e. probably higher than the apparent cost of capital. This could suggest less intensive use than might be thought desirable by yield-maximizing biologists or profit-maximizing economists. Decisions on how much less can be approximated with farmers during research and verification trials.

Finally, we believe that the non-experimental factors, those which were not part of the yes-no trials, are best set to match practices followed by representative farmers. These variables are not important in determining yields or costs--or else they would be among the experimental variables--so they can be set at low-cost rather than at high-cost levels.

Each year, best-bet strategies must be reformulated in terms of the on-farm trials of the previous year and the impressions of all participants in the trials. They are also modified to incorporate findings from experiment station research. Once farmers and researchers are convinced that an appropriate strategy is available, i.e. one consistent with farmers' circumstances and promising significant improvement in income at acceptable risk, the strategy is verified on a larger number of representative sites. Once verified, firm recommendations are made.

Notice this process accents immediacy where improved technologies are available in the near future. If all goes well--if the proper elements have been integrated in the research--the recommended technologies will be widely and rapidly diffused. This occurs precisely because they have been deliberately tailored to fit the needs of the representative farmers in appropriate areas.

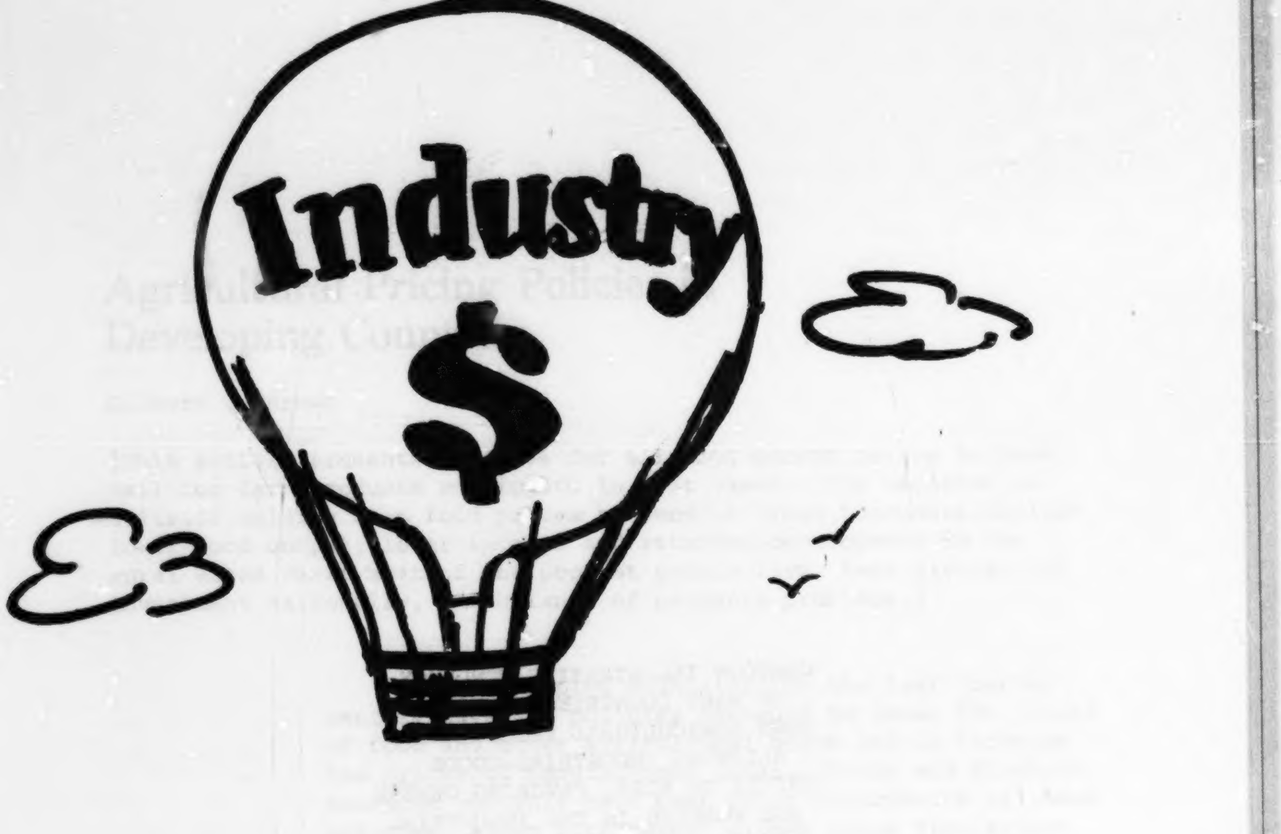
Over time, individual farmers will adjust the recommendations in the light of their particular circumstances. Experiment station results, e.g. new varieties, will be available for testing under farmers' circumstances and incorporated in new best-bet strategies. In the longer run, researchers will turn their attention to other environments or to other problems of lesser importance in the same environment. The process then, provides for continuing improvement in recommended technologies as both farmers and researchers--from on-farm trials and from experiment stations--apply new experience and information to farmer problems.

Incentives and Structure

The process described here rests squarely on bringing publicly sponsored researchers together around the problems of representative farmers. By basing research on representative natural and economic circumstances, researchers will play that important integrative role. In many cases, however, implementing such research will require changes in incentives and in work rules. For at least some researchers, professional incentives must favor contributions to representative farmers and to production; also, work rules must facilitate on-farm efforts.

Before making these changes, of course, the utility of the procedures themselves must be demonstrated. We believe that favorable evidence is accumulating rapidly. Already several national programs that CIMMYT has sponsored are recasting research in terms of the earlier discussion, and their on-farm activities are showing new solutions for the problems of representative farmers. These solutions are moving towards verification. We have yet to see whether they give rise to recommendations suitable for the target groups of farmers , but we are optimistic about developments.

[Extracted from a paper presented at the Seminar on Socio-Economic Aspects of Agricultural Research in Developing Countries; May 1979, Santiago, Chile.]


Industry
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AGRICULTURAL PRICING POLICY

CARTOON ILLUSTRATING TENDENCY
IN MANY COUNTRIES TO HOLD
DOWN AGRICULTURAL PRICES WHILE
ALLOWING INDUSTRIAL GOODS
PRICES TO RISE, FAVORING OWNERS
AND WORKERS IN THE INDUSTRIAL
SECTOR. (GRAPHICS: BARBIERI
AND GREEN, WASHINGTON, D.C.)

Agricultural Pricing Policies in Developing Countries

Gilbert T. Brown

[This article presents the case for allowing market prices to prevail for farm products and inputs in most cases. The negative results of holding down food prices to benefit urban consumers include lower food output, lower incomes and retarded development in the rural areas where most of the poorest people live, less savings and investment nationally, and balance of payments problems.]

Most developing countries for the last quarter century have had policies designed to lower the prices of food and other agricultural goods and to increase the prices of manufactured goods. Trade and foreign-exchange controls have been major instruments of these policies, along with taxes, direct price regulations and other market-control measures. The conventional wisdom supporting this twisting of the terms of trade against agriculture has had four main pillars, based on the assumptions:

(1) that aggregate agricultural production is not very responsive to price changes;

(2) that the chief beneficiaries of higher prices would be the larger-size farmers;

(3) that higher food and other agriculture-related prices such as clothing would most adversely affect low-income consumers; and

(4) that manufacturing provides a more rapid means of growth, and that achieving that

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> growth depends upon large transfers of income (profits) and foreign exchange from agriculture to manufacturing. Thus, policies that depress agricultural prices and increase manufacturing prices have been expected to result in more rapid economic growth and in a more equal distribution of income as well.

Lagging agricultural production and a slowing of economic growth rates in many developing countries that followed such policies, however, have led to increasing concern about measures that reduce farm incomes and incentives. Argentina, Egypt, Kenya, the Ivory Coast, Pakistan, Peru, the Philippines, Thailand, and Uruguay are among the countries which have acted to significantly increase agricultural relative to nonagricultural prices in the 1970s. Greater emphasis in the development literature on rural-development strategies, and on strategies to meet basic needs and to benefit persons in the lowest 40 percent of the income distribution, has also provided new intellectual support for price policies more favorable to agriculture, such as lessened subsidies for capital goods, less overvalued exchange rates and protection for industry, and increased production of foodstuffs and other wage goods.

In contrast to those of the developing countries, price policies in the industrialized countries during this period have been distorted in favor of rather than against the farmer; the typical problem has been overproduction rather than underproduction of agricultural commodities. Moreover, greater agricultural productivity per hectare in industrialized than in developing countries is a phenomenon that has occurred largely since the 1930s, and within the period of differential price policies. In the period 1934-38, grain yields averaged 1.15 tons per hectare in industrial countries, and 1.14 tons (i.e., the same level) in developing countries. By 1975, however, grain yields in industrial countries were more than double those in developing countries, 3.0 tons versus 1.4 tons per hectare. This is not to argue, of course, that the more rapid growth in agricultural yields and production in the industrialized countries is due solely to differences in price policies. A plausible hypothesis is that both the more favorable farm prices and the more rapid growth of farm yields in industrial countries reflect efforts to support farm incomes and increase agricultural productivity, while developing countries have generally been much more concerned about increasing industrial incentives and production, and urban incomes.

The focus of this paper is not on the factors that explain the differences in growth rates between developed and developing countries, however, but on the effects of prevalent pricing policies in today's developing countries. My hypothesis is that agricultural production, income distribution, and economic growth would all benefit from reduction or elimination of "distortions" that reduce agriculture's domestic terms of trade. By distortions, I mean government policies which change prices from what they would be in a free market with no controls. The relations of agriculture's domestic terms of trade to income distribution and economic growth particularly are complex problems too important to neglect.

Several general problems of terminology or analysis should be briefly mentioned. References to "free-market" prices are to those that would exist in the absence of specific controls and policies that now distort the relation of agricultural to nonagricultural prices, including those relationships that magnify differences between domestic and world-market prices. This is not to imply that world-market prices are "free," or that policy should aim to equate domestic and world-market prices or price relatives at all times. Neither is it to imply that "shadow" free-market prices (i.e. those which would be found under perfect market conditions) can be known with exactitude; we are inevitably dealing with a second-best or even third-best world. Rather, the comparison to probable prices "in the absence of controls" reflects only a judgment about approximate price relationships (e.g. too high, or too low). References to changes in prices are to changes from existing distorted price relations. It must be remembered, however, that prices are an incomplete measure of incentives. If agriculture's relative productivity is increasing, it is possible for agricultural incomes and incentives to be growing at the same time that agricultural prices are declining. A fundamental distinction must be made between measures such as price controls, taxes, and subsidies that artificially lower food and agricultural prices, and measures such as on-farm investment, technological advances, and rural infrastructure development (e.g., roads, electricity, and water), that lower prices by lowering the real costs of production. Reductions in real resource costs of production can benefit urban dwellers, farmers, and rural laborers alike.

Pricing Policies and Agricultural Production

Efficient use of resources. Higher prices may stimulate agricultural production by causing farmers to use more labor and other variable resource inputs to reach higher output levels with existing methods of production, or by inducing investment and the discovery and adoption of new agricultural technologies that result in new, lower-cost production possibilities.

The usual empirical basis of arguments that agricultural production is not very responsive to price changes rests upon low price elasticities derived from multiple-correlation analysis of the acreage or output of a particular crop in relation to the relative prices of that crop versus others, or to several presumably independent variables such as output price and use of fertilizer, labor, and water. This multiple-correlation methodology can be faulted on several grounds, including the lack of independence between prices, on one hand, and the level of use of fertilizer and other inputs. The use of acreage rather than output in most such studies underestimates the price elasticity of production by not taking account of changes in yields, which for some years have been accounting for more than half the annual growth in world food-grain production. Also, it is doubtful that yearly fluctuations in prices can adequately represent the changes in the longer-run income expectations that determine rates of investment in agriculture and the adoption of new techniques. These decisions appear to depend more upon whether expected profitability is above or below a "threshold" level of acceptability, which may be little affected by yearly price fluctuations unless these cause longer-run expectations of profitability to change. Moreover, incentives are a function of net income and not just prices, so that a new technology may importantly change the incentive effect of a given set of prices--as happened during the Green Revolution in wheat and rice.

Price incentives can cause farmers to use improved seeds, along with more fertilizer, pesticides, and other purchased inputs, to adopt improved cultural practices, and to apply more family or hired labor. All of these ways of increasing the efficiency of resource use may occur at once, for example, if a small farmer decides to reduce or give up his off-farm employment--or a son does not migrate to the city--in order to adopt the more labor-intensive techniques required to reap the benefits of new varieties. Generalities about most small farmers as "subsistence" farmers unaffected by agricultural prices are highly misleading.

Timmer and Falcon (1975) found a close rank correlation between unmilled rice prices and rice yields among Asian countries. For 1970, rice yields varied from 5.64 and 4.55 metric tons per hectare in Japan and South Korea to 1.7-2.1 tons per hectare in Indonesia, Thailand, the Philippines, and Burma. At the same time, the ratio of the price of a kilogram of rice to the price of a kilogram of fertilizer nutrients showed a similar wide variation, from 1.43 and .96 in Japan and Korea to 0.1-0.4 in the other countries. This pattern of relationships between prices and yields cannot be explained as a short-term response, but reflects long-standing differences in price policies among these countries. It appears to indicate long-run responsiveness of production to incentives. It is noteworthy that the three countries with the highest yields--Japan, South Korea, and Taiwan--have some of the poorest soils among the nine countries studied. The high prices to farmers in these countries appear necessary to cover the costs of achieving these yields under the given climatic, soil and other conditions; the decisions to pay such high prices may have been primarily political. It is interesting to speculate to what levels rice yields and production would fall in Japan if farmers there received the same price as Thai farmers, or conversely the levels to which rice yields and production would climb in Thailand within a few years if Thai farmers faced the same rice and fertilizer prices as Japanese farmers.

Shifts in the production function. The most important long-run effects of price incentives on production may be through price-induced shifts in the production function (i.e. development of new technologies) rather than through greater efficiency of resource use with existing production functions (technologies). These long-run effects depend upon the extent to which the incentive structure has an important effect on scientific research and on adoption of new techniques by farmers, on public and private investment related to agriculture, and on institutional changes such as land reform, extension services, marketing, and distribution facilities.

Clear links have been demonstrated between prices and the timing and nature of new technological discoveries, and also the adoption of these techniques by farmers. Much of the agricultural research initiated since the late-1973 jump in oil prices is "energy saving," with heavy emphasis on reducing fertilizer requirements--for example, through nitrogen fixation, seed treatment, and placing a small amount of fertilizer close to the seed or seedling roots. Studies of the diffusion of new techniques and of new investment in developing countries indicate that where profitability of adopting a new technique or investing, say in a tube well, is very high, that the new techniques will be rapidly adopted and the new investment quickly made. At least there are wealthy individuals who make choices between agricultural and nonfarm investments. A large proportion of upper- and even middle-class individuals in South Asia, for example, reside in cities but own substantial farmland operated by a hired manager, tenant or a relative. For these individuals, as for the small farmer deciding how to divide his time between his own farm and other employment, the choices between farm vs. nonfarm investment and labor are recurring ones. Higher returns to farming certainly attract more labor and more investment into farming--other things being equal. Nearly all studies show high marginal saving rates among even poor farmers. Thus, an important part of the additional income accruing to farmers through higher prices is likely to result in greater savings and investment. In countries where farm yields are low and returns to additional investment in agriculture are high (e.g., where fertilizer use is well below optimal levels), an important part of that saving is likely to be invested in farming.

Public investment and institutional changes may also be importantly affected by prices, but research on these topics is in its infancy so the evidence is scarce.

Income Distribution

Low prices for food and other farm products are politically popular on the theory that they increase real incomes and employment of the urban poor, and that the only losers are large farmers. There is a high cost attached to such low prices, however, if their effect is to retard cost-reducing investment and innovation in agriculture. Competition between farmers and traders assures that most of any decline in unit costs would be passed on to consumers in lower prices, even though farm incomes rise. Moreover, studies of the effects of price distortions and controls in specific countries usually conclude that it is the upper- and middle-income urban groups (including employers) and large farmers who are the chief beneficiaries.

The argument that higher food prices hurt low-income urban consumers who have to buy most of their foodstuffs is usually based on the short-term income effects of higher food prices on the assumption of unchanged incomes. These studies tend to ignore even relatively short-run adjustment processes that reduce the income loss, such as shifts in consumer demand toward substitute foodstuffs, and the fact that in low-income countries urban wages usually respond fairly quickly to the cost of basic foodstuffs. The logic of the common argument in developing countries that food prices must be kept low in order to assure the competitiveness of manufactured exports rests entirely on this relationship between the two. The benefit to employers of below-market agricultural prices is even clearer in the case of nonfoodstuffs: cotton yarn and textile manufacturers in Pakistan, for example, for many years have been able to buy cotton from farmers, many of whom are quite poor, at no more than two-thirds and sometimes half of world market prices because of foreign exchange and export tax controls; but they sell much of their output at world market prices.

Price and production controls that are intended to provide low-cost food to poor urban groups also tend to divert production away from those cheaper food crops. In Peru, low official prices have greatly reduced production of *frijol canario*, a popular bean which has been a major source of protein for low-income urban consumers; the limited output is being channeled through black markets at prices about 60 percent above the official control prices. In Egypt, farmers have increasingly diverted land, fertilizer, and other inputs from growing wheat, maize, rice, and cotton--for which they are given quotas to sell to the government at low, controlled prices--to growing fruits, vegetables, and livestock, which are not price-controlled. This diversion helps assure a supply of these latter foods for upper-income urbanites, but at a high cost in the balance of payments and in massive budget subsidies to lower the retail price of imported wheat. In Kenya, price ceilings on meat and maize transfer income from low-income herdsmen and farmers for the benefit of middle- and upper-income urban dwellers.

Marketing controls. Most developing-country controls on price margins and marketing between farmers and consumers are supposed to protect consumers against "monopolistic" traders. The few significant studies of such controls, however, suggest that such interventions frequently have very adverse effects on efficiency, production, and income distribution. The most comprehensive Indian study concluded that the private grain market was highly competitive, that traders operated efficiently within government-imposed technological and policy constraints, and that government efforts, rather than being expended in market controls, could have been much more fruitfully directed toward helping to improve the competitive environment, including improved farm-to-market transportation facilities, dissemination of market price and stock information, and managing national support price and buffer stock programs. Periodic threats by the Indian government during the prior twenty-five years to nationalize all trade in grains, and the issuing of new rice-milling licenses primarily to cooperatives and public-sector firms, however, had resulted in very little private investment to improve either storage or milling facilities. Furthermore, government-agency marketing costs are several times as high as those of private traders, who flourish despite government policies.

A study in Peru concluded that marketing measures initiated to eliminate abuses by middlemen represented one of the major constraints limiting agricultural production, and might drive out private marketing talent with no comparable gain in public-sector expertise. Because of stringent laws and penalties against speculation and monopolization, there is little private investment in storage facilities in Peru. This lack of storage facilities results in periodic gluts, scarcities, and excessive price fluctuations as wholesale truckers move products between consumption centers on a day-to-day basis to take advantage of price differences among different areas.

Input subsidies and income distribution. Farm subsidies also benefit primarily middle- and upper-income farmers in low-income countries. Large-scale farmers buy most subsidized inputs. Poorer farmers usually lack the money to buy adequate amounts of fertilizer and pesticides, and are commonly unable to get credit except at near-prohibitive private rates of often 60 to 100 percent per year. In countries with subsidized bank credit for agriculture, rich farmers tend to get most of the credit through open or disguised bribery. Subsidy programs for tractors, tube wells, and other fixed investments also go mostly to the largest and richest farmers. Data from

Kenya indicate that about 80 percent of fertilizer, which has been subsidized for many years, has gone to large farmers.

Development Strategy and Agricultural Pricing

The ultimate question about agricultural pricing policies is their effect on economic development, including income distribution and social consequences. We are unable to model and quantify adequately an entire economy in a way that measures its complete response to variations in relative prices. We can progress toward that goal, however, by examining the effects of agricultural-pricing policies on government budgets, national saving and investment, and the balance of payments.

Government budgets. Revenue and expenditure data shed further light on the effect of government actions on farmer incentives and income distribution. We have made calculations of the transfers of resources among producers, consumers, and the government due to the effect of government measures on the prices received by farmers and the prices paid by consumers for wheat in Pakistan in various years between 1966 and 1976. These show a large transfer of income from wheat producers to consumers through lower-than-world-market prices for domestic wheat, including that procured by the government. These transfers are estimated at 348 million rupees in 1966 and 1,540 million rupees in 1976, and they equalled 62 percent of the income received by farmers from marketed wheat in the former year and 52 percent in the latter. At the same time the farmers received budgeted government subsidies on inputs used in producing wheat equal to about 7 percent of the domestic value of marketed wheat at domestic prices in 1966 and 10 percent in 1976. Consumers received transfers from less-than-world prices for their purchases in the private market, and from sales through officially controlled ration shops, of both domestic and imported wheat at substantially less than their cost to the government. The net result of these transactions has been a large income transfer from producers (1,237 million rupees in 1976) equal to 41 percent of the value of marketed wheat at domestic prices, and a large income transfer to consumers (3,280 million rupees in 1976) equal to somewhat more than the total payment to domestic farmers for their entire crop of marketed wheat.

One of the important questions is whether the benefits of these subsidies in providing lower-cost wheat to consumers are as great as their costs. The economic and social costs are increases in taxes and/or government borrowing, or of decreases in other government expenditures--perhaps a combination of these. All consumers are beneficiaries of the system, whether they buy government-rationed and price-controlled wheat or make their purchases in private markets. The cost of these subsidies weighs heavily on small "subsistence-level" farmers. In Pakistan, such farmers sell more than 30 percent of all marketed wheat but receive only a small fraction of the fertilizer, pesticide, tube well, tractor, and other subsidies. The average real income of these small farmers is considerably below the average urban income.

As for cost effectiveness in reaching really poor consumers, many of those in the lowest 40 percent of the income distribution are farmers or rural workers who would benefit from higher farm prices; and some of the poorest urban dwellers would have stayed on or returned to farms if farm prices and incomes had been higher. These facts suggest that low food prices penalize rather than help many of the poor. The 2 billion rupees of government budget subsidies to lower wheat prices in 1976 amounted to one-half the value of all marketed wheat, including imported wheat. Thus, on budgetary grounds alone, ignoring production and other indirect effects, this is an extremely expensive way to provide low-priced wheat to those who are in real poverty; it could be done at much less expense through a direct food subsidy or other income-supplement program directed to the needy and malnourished.

A typical and in no way exceptional example of the relation of the cost of these budget subsidies to expenditures on agricultural extension, research, education, and statistics is available from Pakistan budget data. For fiscal year 1975, subsidies to consumers for wheat and to farmers for purchased inputs at the provincial and national government levels were budgeted to equal about 60 percent of all other current and capital expenditures on agriculture, irrigation, and water development projects. The cost of subsidies was drastically underestimated, however, and actual payments amounted to about 90 percent of the budgeted level of the type of expenditures noted. Actual wheat subsidies were forty-four times as great as budgeted expenditures on extension services, and fifteen times the total budgeted expenditures on agricultural extension, research, education, and statistics. It seems unlikely that the benefits of wheat subsidies were as great as would have been a near doubling of the real resources devoted to all agriculture and water development programs. It also seems likely that increased expenditures on these latter categories would have done far more than the subsidies to lower food prices, though with a time lag.

Taxation. There is a substantial literature on the economic advantages of direct rather than indirect taxation of agriculture, since land and income taxes do not directly affect either relative product prices, cropping patterns, input/output price ratios, or the output levels from which farmers will realize the maximum levels of income. High levels of land taxation were very successfully used, both to stimulate agricultural output and to transfer resources to the government and to industry, during the modernization of agriculture in Japan and in colonial India. However, the lack of significant levels of such taxation in most developing countries today, and the presumed administrative as well as political difficulties in their imposition, are often cited as reasons for focusing on indirect taxation of agricultural commodities, and particularly on taxation of exports. Changes in taxation would be a budgetary requirement of price and subsidy changes in many countries. A package combining higher output prices with reduced subsidies and increased land taxation could work to everyone's interest, and be more politically acceptable than a change only in prices and subsidies.

Savings and investment. The effects of pricing policies on national saving are obviously very complex. Budget subsidies to consumers during the high grain prices of the 1970s rose to roughly one-fourth of total government expenditures in some food-deficit countries such as Egypt and Pakistan, and to as much as 5 percent of gross domestic products. These were exceptional years; but such subsidies are typically still a significant drain on saving and hence on resources available to finance investment.

Substantial savings may also be lost through income transfers from agriculture to the rest of the economy through price distortions. Studies of private saving rates among rural and urban groups show higher marginal saving rates in rural than in urban areas. Furthermore, small-farmer marginal saving rates appear to be almost as high as those of large farmers. Farm saving rates might have been further increased if pricing policies had made investment in agriculture more attractive. Thus, the distortion of input and product prices in order to funnel income away from farmers and toward industry may have significantly reduced national rates of saving and, therefore, of investment. Rates of overall economic growth may hence have suffered from lower rates of saving and investment as well as from misallocation of budget and investment funds. This is just the opposite effect, of course, from that predicted by economists who argued in the 1950s and 1960s, from inadequate empirical data, that marginal saving rates of the urban sector and industrialists were higher than those of farmers.

Observation of the industrial sector in many developing countries suggests that relatively little productive investment may result from the involuntary transfer of income from agriculture to industry. Rates of utilization of physical capital in industry are extremely low in these countries. Moreover, much of the income transferred may not even result in productive investment but may be frittered away in inefficiency and increased consumption, such as in wage increases to already relatively high-income industrial workers, additional unneeded employment of workers (especially in public-sector industry), or increased consumption by managers.

Balance of payments. While the totality of potential effects of relative changes in agricultural prices upon the balance of payments is very complex, spectacular balance of payments changes appear feasible in some countries by reducing price distortions against agriculture. Kenya's move in early 1975 toward world-market prices for both agricultural products and inputs has virtually eliminated previous large expenditures for wheat and sugar imports, both by increasing domestic production of these crops and by cutting demand for each by about 20 percent through substitution of other domestic foodstuffs. Reduction of subsidies on imported farm equipment that have mostly benefited rich farmers and encouraged capital-intensive and import-intensive agricultural production techniques seems to be simultaneously strengthening the balance of payments, increasing wheat production and lowering its cost, and improving incomes and employment among relatively poorer sections of Kenya's rural population. By contrast, declines in rice exports from Burma, and in agricultural exports from Pakistan and Egypt, are only a few examples of the sometimes very substantial declines in export earnings that have resulted from paying farmers much less than the market value of their crops.

Higher agricultural prices closer to market level might also significantly reduce nonfood imports by changing the distribution of income and hence the composition of demand. If less discrimination against agricultural prices shifted income distribution in favor of farmers, there would be changes in the composition as well as the level of demand for both consumption and investment goods. Research indicates that such shifts would tend to increase demand for labor-intensive domestic products and reduce demand for capital-intensive and imported products.

Conclusions

Analysis of the significance of price policy in general and agricultural price policy in particular has not kept up with practical experience concerning policies affecting prices in developing countries or with changes in development-strategy theories. There are several types of studies that might be especially useful in advancing our knowledge of the responses of farmers and of national economies to price changes. First, detailed case studies of the decisionmaking of individual farmers are badly needed. Much of our "conventional wisdom" about farm-level response to changes in agricultural prices, for instance, is based upon aggregative data. Studies have only recently begun on how developing-country farmers of different income levels spend their time and earn their incomes.

Second, detailed case studies of the effect of particular price policies in individual countries are needed. Evidence from various sources has been presented in this paper about some consequences of particular price policies in particular countries. Such material needs to be much more systematically examined and incorporated into the knowledge of development specialists and policy makers; information is available and is too often regarded as interesting anecdotal case material. The problem is too important to neglect. In the process of seeing what can be accomplished with current tools of analysis, new analytical breakthroughs appear likely.

Third, it is important that the overall structure of price policies be studied, along with the place of price policy in overall economic policy. Such studies have generally not been undertaken because they are considered "unwieldy," "vague," and too big to be productive. Nevertheless, the examples cited here of the neglect of agricultural pricing issues suggest that these issues are also too important not to be the subject of some direct work, rather than always working with the pieces. These studies will necessarily be national studies initially. It would also be useful to look at comparative policy structure and growth experiences in different developing countries since perhaps 1950. For example, what were the characteristics of price policy and overall economic policy in countries with rapid overall growth, and how did these policies compare with those of countries which experienced difficulties?

Fourth, the role which developed countries could play in helping to overcome agricultural pricing policy problems in developing countries should be examined. For instance, could foreign aid help to finance a phased adjustment in urban food prices over several years, both to avoid sharp short-term income effects from higher prices and to cover the period between the undertaking of farm-level price increases and the actual achievement of increased and cheaper food-grain supplies? Developed countries could also make an important contribution by managing their own agricultural production and import and export programs so as to minimize disruptions to world markets.

[Extracted from Distortions of Agricultural Incentives, Theodore W. Schultz, editor, pp. 83-101. Copyright© 1978 by Indiana University Press, Bloomington, Indiana.]

Agricultural Price Management in Egypt

William Cuddihy

[A World Bank study of the effects of Egyptian agricultural price controls and related interventions since 1952 concludes that most of the results were adverse: slow growth or decline in yields and output, too little investment except for luxury food products, with the greatest negative impact on the poor farmers and the poorest sector of the population.]

For many years after the 1952 Revolution Egyptian agriculture had been associated with excellent yields and a well managed program of agrarian reform. Over the last ten years, though, growth rates in yields of many important crops like sugarcane and cotton have fallen, and rising food import costs have become an important competitor for foreign exchange needed for industrial development. By 1976 the foreign exchange cost of agricultural imports was 70 percent more than the foreign exchange earnings from agricultural exports. The government's Five Year Plan, 1978-82, voices the official opinion that agriculture has become a problem because its performance is consistently below expectations and has become increasingly difficult to administer. Public administrators complain of "peasant perversity" in not accepting new technology, in not cooperating with the State's production plans for the common good, and in not responding correctly to the price increases conceded them. Farmers complain of government interference in markets that leads to low crop prices, fertilizer shortages, and forced membership in unpopular cooperatives. This paper is the result of a detailed examination of Egypt's use of market intervention as a major tool of economic management.

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Sector Background

Although Egypt has adopted a conscious policy of industrialization since 1952, the country remains essentially an agrarian one, and the industrial drive has resulted in a manufacturing sector which has failed to absorb sufficient labor migrating from the rural areas. The industrial development has been financed basically by taxing the agricultural surplus.

Egypt's farmland is a long narrow oasis in a large desert. Only three percent of the total land area is cultivated, and there is little scope for extending it since it depends on water from the Nile River. The population density relative to the arable area is very high (12.5 per hectare), and the average size of holdings is very small at 1.47 ha. The cultivated area, however, has fertile soils--mostly riparian silts and clays of great depths and uniformity--and the land is well suited and the long hours of sunlight permit excellent growth rates. The development of the irrigation network has resulted in cropping intensity of 190 percent in a complex rotational system.

Maize and sorghum are the main subsistence crops, while wheat, beans, and onions are the leading winter cash crops; cotton and rice are the main summer cash crops. Berseem has become an important cash crop for feed for draft animals, upon which Egyptian agriculture depends, and for beef feedlot operations. Crop yields have either declined (cotton, rice, sugar and beans) or risen very slowly (wheat and maize). One result of this is that Egypt has changed from being a net exporter into a net importer of wheat; and cotton and rice exports have declined.

Public investment in agriculture has been considerable since the Revolution, with most of the funds going to finance the Aswan High Dam and to opening up fringe desert areas for irrigation. The results of reclaiming new marginal lands have been disappointing so far, and there has been too little investment in projects intended to raise productivity on the old lands. The major evidence for this conclusion is the lagging growth rates in yields for major crops and even declines in the yields. Farmers are organized in government-operated cooperatives; they receive most of their inputs through the cooperatives, and have to sell varying proportions of their outputs to them. Evasion of planting requirements and sales quotas is believed to be widespread, with many farmers prepared to pay the fines if caught.

Goals and Policies

Egyptian agricultural development strategy derives from two sets of policies, which this study shows have tended to conflict with each other. On the one hand, the strategy embodies an industry-led policy of economic development which was widely recommended in the 1950s. That policy was based on the theory that, since productivity is generally higher in manufacturing than in agriculture, priority should be given to industrialization; other sectors will then benefit from the trickle-down effects. The policy instruments for achieving the strategy have been (a) taxation of the agricultural surplus to provide the industrial investment funds; (b) protection for infant manufacturing industries; and (c) maintenance of relatively low industrial costs through cheap food and low wages. The policy instruments certainly worked: the agricultural surplus was tapped, industries were protected, and the price of basic foods, particularly bread, was kept low despite inflation.

The second set of policies are distributional in intention, and were rooted in the revolutionary reaction to the onerous conditions in the countryside prior to the revolution. Along with the land reform--the basic means of redistribution--a number of physical controls (state ownership and state production, private controls and subsidies) were introduced. From time to time, in response to pressures and changing situations, additions and changes were made which have now resulted in a patchwork of uncoordinated market interventions.

Effects of Policy Instruments

Effect on prices. If one compares import or export prices, adjusted to the farmgate by deducting the costs for transport, trade and processing (that is, "border prices"), with the prices actually paid to farmers, one finds long run "taxation" of export crops, little difference for basic foodgrains, and "subsidization" of meat and sugar production. (Taxation, as used here, means that border prices are higher than actual farm prices; subsidization is the opposite.) Between 1965 and 1972 the tax rate measured in this way--"nominal protection"--was around 30 percent for the export crops of cotton, rice and onions. Wheat and maize prices were close to border prices, whereas those for meat were well over twice the import equivalent. During this period world prices of sugar were very low. Processing costs occasionally exceeded the price of the final product for some crops. A sharp change occurred between 1973 and 1976 when the world prices rose dramatically while Egypt's administrators kept local prices constant, resulting in taxation of all products except meat. The tax rate on cotton, rice and onions peaked at 60 percent, 80 percent and 60 percent respectively, then began to fall as domestic producer prices were increased and border prices started to decline. Wheat and maize price taxation reached 30 percent, and the sugar subsidy became a 70 percent tax. Local price rises for meat matched foreign gains, and the subsidy rate remained constant. The spectacular widening of price distortions at that time led to markedly increased attention being paid to market problems.

The tax rates on output prices as measured by nominal protection do not tell the full story since certain inputs and services are also provided at distorted prices. For instance, domestic fertilizer prices have been kept constant since 1961 while import prices have fallen and risen. Between 1965 and 1973 this practice resulted in farmers paying up to 87 percent more for their fertilizer, obtainable only from the state monopoly. Between 1973 and 1976, as world prices escalated, the same policy resulted in their paying only half the world price. For all the other purchased farm inputs there has been a subsidy in all years, mostly the result of rising world prices diverging from constant domestic prices. By 1976, fuel, pesticides, interest rates, tractor purchase, trading charges, rents, and land taxes were all subsidized by some 50 percent. Irrigation water was still free, and improved seeds received subsidies--up to 30 percent for hybrid maize. The long run practice has been a net subsidy on inputs gradually rising to a weighted average of around 50 percent.

The combined effect of these distortions is a long-run net tax on the agricultural sector estimated at 30 percent of value added. Since the estimates of "effective protection" rates, which include input subsidies, do not markedly differ from those for "nominal protection" which looks at output prices only, the value of input subsidies does very little to compensate for the value of product taxes. The budget cost of all direct and indirect producer subsidies between 1973 and 1976 is shown as £E 602 million. This includes all explicit subsidies on all crops, the current expenditure of both the Ministries of Agriculture and of Irrigation to provide water and services, plus all state investment in the sector. The direct state revenue, net of payments to growers, from cotton sales alone was £E 892 million arising from use of the discriminatory overvalued exchange rate and from price differentials in terms of local currency. In other words, state revenues from cotton alone more than paid for all state expenditure in agriculture. To the cotton revenue must be added the value of the 50 percent tax rate on rice and onion exports, as well as the differentials on the value of orange exports. Similarly, the substantial implicit transfers to consumers by setting relatively low producer prices for wheat, maize and sugar in this period should be included as state revenue.

Measurement of the effects of market intervention on farm prices is important for national development only where prices matter. The planners' implicit assumption that prices do not matter, which was central to Egypt's policy planning, is based on the following reasons: (1) offsetting measures like consumer subsidies can be used to correct income imbalances; (2) non-price controls can be applied to restrict resource reallocation in response to price signals;

(3) direct state investment can divert resources to projects regardless of market signals about profit expectations.

Effect on cropping patterns. Our analysis of farmers' response to price changes over the 25 years since 1952 by use of regression equations shows significant correlation of relative prices with yields and cropping patterns. Both planted area, a measure of land allocation, and yields, a measure of the use of other inputs, have varied positively with changes in the relative prices of outputs over the long run. However, the short-run responses were much limited by rotational requirements, by poor access to markets for high priced perishable products, and the paucity of the farmers' resources as well as by policy controls on the supply of inputs and the pattern of production. These results are confirmed by field observations, and acknowledged by the government. Some examples of the ways in which farmers react to price situations and get around government controls are as follows: Secondary markets are very active in the reselling of fertilizer alloted to each farmer in fixed amounts on the basis of the expected area of each of his crops. Every year many thousands of farmers pay a fine rather than conform to the production plan set for them; for cotton, the number reached 180,000 in 1974. Sugar producers at that time diverted some 40 percent of their production away from the lower priced official markets.

The evidence clearly shows that prices have indeed mattered, in influencing what was produced, how it was grown and what was marketed, and that the planners' assumptions to the contrary have been invalid for a long time. But in the short run the degree of response has been severely limited by non-price constraints. The complexity of the relationships is borne out by empirical results which show, for example, a high long run elasticity of area planted with respect to income from rice (0.91) and wheat (0.46), and a high cross elasticity (9.95) between wheat and cotton. On the other hand, while both maize and cotton showed negative area response to their own prices, they both showed high yield response to output price changes.

The major conclusion of a study using linear programming of price effects on the structure of production [description omitted here] is that both prices and policy controls have had a major impact on the composition of the marketed surplus as well as on the total cropping pattern. It is clear that the desired production plan at the national level could be achieved with a less complex system of offsetting market controls and distorted prices which would be easier to manage; the optimum simulation, with farmers facing border prices for all outputs and inputs, would increase farm incomes by 40 percent.

Effect on input use. Price effects on the efficiency of input use have been important only in the case of irrigation water, where studies show that free water has led to considerable wastage. Of the other inputs, price ratios have had little effect in determining the choice of technique since the quantities used have generally been restricted to a level well below the point where the value of the marginal product equals the cost. Secondary fertilizer trading has helped rationalize its use; application of cotton pesticide by government agencies is independent of farmer decisions; and the supply of machinery has been restricted. The best example of the ineffectiveness of price measures to influence technology innovations is the case of high-yielding grain varieties (HYV). Despite a seed price subsidy rising to 30 percent and an extension campaign to encourage its use, less than 1 percent of the rice area is under HYV varieties, compared to 64 percent for the Philippines and 30 percent for India. In the case of wheat, only 15 percent of total plantings were with HYVs, compared to 62 percent for India and Pakistan and 50 percent for the Sudan. The area under HYV wheat rose from 5 percent in 1973 to 37 percent in 1974 and dropped back to 13 percent in 1975. Reasons for rejection were: (1) the grain quality was not acceptable to consumers; (2) the ratio of straw to grain was too low to meet animal fodder requirements; (3) local adaption by researchers was insufficient to make HYVs as disease resistant as local varieties; (4) the cultural demands of the HYVs do not fit into the common farm systems.

Effect on aggregate output. Over the long run, the rate of change in technology and the growth in aggregate output in agriculture are functions of investment. Secular movements in commodity and factor prices determine the pattern and level of private sector investment allocation, both within agriculture and between it and other sectors. State investment has worked through direct resource allocation within the central plan; government-set prices determine the rate and origin of public savings mobilization from the sector, and hence the degree to which public investment substitutes for private investment. Most of the relatively minor amount of private investment has been directed to orchards, with little or no price distortion on output but considerable product-price protection. State funds have gone into infrastructure such as irrigation, drainage, land reclamation, research and extension with mixed success. Technology-changing investment in the traditional crops comprising most of the value of output has been relatively minor. The net result is that the long-run growth rate in agricultural production at constant prices has been low. The figure for Egypt is 1.3 percent per year, while for the developing countries as a whole it has been 2.6 percent and for the developed countries 1.8 percent. Egyptian crop yields no longer lead the world in major crops as in the sixties. Under a different set of long-run prices it would be fair to expect a more positive pattern and level of investment, and a different rate of growth in aggregate production.

Effects on incomes. The income effects of price management have proven to be regressive--i.e. unfavorable to the lower incomes. The analysis indicates a long-run average tax rate for the sector in the order of 30 percent, which is 20 percent higher than the average 25 percent tax rate as a percentage of GNP for the economy as a whole. Average incomes in agriculture are less than those for the rest of the economy by 25 percent. Despite the inexactness of some of the numbers involved, the orders of magnitude do indicate that the policy objective of equity between rural and urban areas has not been achieved by price management: incomes in agriculture have been depressed by policy instruments. On the other hand, since agriculture is the largest sector, this is where the largest part of the tax base lies. The problem is in devising a tax system to achieve both the revenue and equity goals simultaneously. Fortunately, the growth in earnings from the Suez Canal and from the remittances of Egyptians working overseas relieves agriculture of some of its heavy burden.

Perhaps more important is the taxation inequity within the sector. The tax incidence varies by crop, and cotton-based farmers bear a greater tax burden than specialist meat producers or fruit growers. To move into the latter crops requires investment, and orchards return no income for several years; feedlot contracts are given only if minimum-scale-of-operation conditions can be met. Long-term farm credit has not been available since the early 1960s, so only those with access to savings from outside the sector can exploit profitable opportunities made possible by the distorted price system. This effectively locks small farmers into a high-taxed cropping pattern. This conclusion is supported by field observation, where orchards were commonly found to be owned by urban-based professionals and where cattle fattening feedlots were commonly found to be operated by the dominant farmer in the village. This situation has occurred because of the inflexibility of price management to changing circumstances. The price control structure has been developed around the "traditional" crops of most importance at the time, and no restructuring has occurred despite the rise in importance of higher-profit "non-traditional" activities. The conclusion for welfare is that prices have mattered in determining relative incomes, and that price management has been regressive both within agriculture and between agriculture and the rest of the economy.

Effect on institutions. The basic questions still remain: Should the state have intervened to such an extent? Should more use have been made of alternatives to price interventions and physical controls? What have been the real resource costs? Following the revolution, and with the implementation of the land reform, administrators were left with the task of reorganizing the agricultural sector. Most of the farmers worked small parcels, had little previous access to credit, and their objectives were based on survival. The prior conditions of serfdom had hardly prepared farmers for a free market system. It is arguable that during a transitional phase to "maturity" the State had little option but to fill at least some of the decision-making vacuum, and to ration goods and services as widely as possible. Even though specific efficiency losses can be ascribed to poor State control, such as the low cotton yields of 1977 due to a breakdown of the pest control operations--yet left alone, the multitude of small farmers, faced with escalating pesticide prices, might not have fared much better. However, there has been no way for farmers and institutions to learn from experience. Here is probably the intervention program's greatest social cost. The agricultural development strategy has put the system into a state of permanent dependence, with low accountability, poor motivation, and with little interest in innovation other than to use the rules to gain individual advantage regardless of their intent. Less stress on price stability, and more frequent changes in the face of rapidly increasing inflation might have resulted in a climate more responsive to change and more conducive to development.

Evaluation of the Net Effects of Market Interventions

A full evaluation of the effects of administered farm taxes and subsidies must assess the effects of policy instruments on productivity and income distribution, not only within the sector being examined but in other sectors as well. This requires more comprehensive, sophisticated, dynamic programming modeling than is possible. Our analysis of market interventions in Egypt had to be based on partial equilibrium analyses; but there can be little doubt that the patchwork of market interventions which have grown up in the years since the revolution have had very significant impacts on:

--productivity (lack of adequate investment in agriculture, particularly in raising productivity of the old lands);

--the output and export of crops (negative on wheat, cotton and rice; positive on livestock; berseem, fruits and vegetables);

--the use of inputs (e.g. waterlogging resulting from wasteful use of irrigation water);

--institutions, which have been unable to respond effectively to the balancing of supply and demand in product and factor markets (balancing which would otherwise be carried out by market forces);

--income distribution within agriculture and between agriculture and other sectors.

The input subsidies have nowhere offset the taxes on producers as the table below illustrates in part. Moreover, although the agricultural surplus has been effectively taxed, most of the taxed surplus has not been used to finance industrial investment as was intended, but was transferred to consumers by way of subsidies. Too little was left for reinvestment in agriculture, and the share that did go to finance industrialization was not successful in creating enough new jobs in efficient manufacturing enterprises to employ those pushed out of agriculture.

Table 1: CONSUMER AND PRODUCER TRANSFERS IN MAJOR CROPS--EGYPT 1974/75
(in £E million at parallel exchange rates)

Crop	Transfer from Producers a/	Transfers to Consumers	Transfer to State
Rice	-562	+518	+ 44
Wheat	- 78	+334	-256
Cotton	-254	+122	+132
Sugar	-400	+ 40	+360
Maize	-120	+249	-129
Meat	+214	-242	+ 28
Total	-1,200	+1,021	+179

a/ Net of input subsidies

Policy Conclusions

What then are the options open to Egypt? It is suggested there are three choices:

- --to have more of the same, but to extend the coverage of physical controls to all agricultural products; and to make the policy instruments internally more consistent;
- --to dismantle all controls, remove all taxes and subsidies and rely entirely on market prices; and
- --to move gradually towards a position of fewer physical controls, less direct and more efficient state production, less discrimination against agriculture as a whole, and a more rational system of taxes and subsidies which would encourage Egyptian farmers to adopt cropping patterns that would be more consistent with their own private needs and with Egypt's long term comparative cost advantages.

The first two alternatives are extreme ones. In view of the failure of the existing strategy, more of the same is unlikely to be successful; but moving quickly to a freer trade position is politically unacceptable and likely to be disruptive in effect. Hence the third alternative is recommended.

[Extracted from the Executive Summary of World Bank Staff Working Paper No. 338, pp. i-x. Copyright© The World Bank, 1980.]

Public Rice Distribution and Welfare in Sri Lanka

James D. Gavan and Indrani Sri Chandrasekara

[While some countries hold food prices down to help consumers, and others keep them high to help farmers, Sri Lanka--although a quite low-income country--has done both: supported farm prices of rice, and supplied rice rations at subsidized prices to almost all consumers. There have been some important benefits, but the cost was very great, and in 1978 the program was curtailed. This article analyzes costs and benefits of the unusual policy.]

Sri Lanka has achieved remarkable social progress for a country with a very modest economic base. Although its per capita income is very little higher than those in India and Pakistan, Sri Lanka has clearly achieved higher literacy and life expectancy, and lower infant mortality, than the other countries in South and Southeast Asia.

This progress appears to be at least in part the result of a series of social policies that have been followed in the country since and in some cases prior to independence. Among these are the food distribution programs. A comprehensive public rice distribution system has operated since World War II. Until 1978, almost the whole population of Sri Lanka received an allotment of rice; most of the time it was paid for by consumers, but at prices below cost. The system involves the distribution of rice at subsidized prices through an extensive network of some 7,400 cooperatives; and an active government program of price supports and procurement of agricultural commodities, particularly rice, to supply the public distribution system. This study explores the operation of the public food distribution system, how it affects

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the price and availability of foods, its impact on the food intake levels and nutrition of different income groups, and its costs.

A comparison of food intake in Sri Lanka with nutritional levels in other poor countries of Asia indicates that average consumption in Sri Lanka is not high and that protein intake is unsatisfactory. But the distribution of the available food among different income groups is remarkably even compared to that in other poor countries. This evenness is a result of relatively modest intake at the higher end of the income scale as well as relatively satisfactory food intake levels at the lower end of the income scale.

Sri Lanka is a food-deficit economy that traditionally has relied on imports of rice and wheat, which are paid for largely by the export of plantation crops. The most important Sri Lankan food staples are rice and coconut. No wheat is grown in the country. The government has pursued a policy of maintaining rice prices to farmers through the Guaranteed Price Scheme, encouraging production; also through irrigation, land settlement, and the subsidization of inputs. Rice production grew very rapidly, tripling from the early 1950s to the early 1970s (from 350,000 tons in 1950-54 to about one million tons). The cereal self-sufficiency ratio almost doubled in 20 years (from .36 to about .60). In the 1970s, however, production stagnated, partly due to droughts and partly to unfavorable rice/fertilizer price ratios.

The Sri Lankan government, through the Food Commissioner's Department, has a monopoly on the international trading of food commodities. The Food Commissioner's Department imports rice and wheat for the public food distribution system. Rice is distributed at subsidized prices through the ration system. Generally, wheat is available in unrestricted quantities at prices that are sometimes taxed and sometimes subsidized. Rice and sugar are distributed largely through a network of authorized distributorships at a fixed markup, whereas wheat is normally available through all retail outlets in the country. Rice is procured from farmers at a guaranteed purchase price by the Paddy Marketing Board, which, during certain periods, has limited all movement of rice within the country. The Board purchases all the rice offered by the farmer.

Operation of the System

Prior to 1966 the distribution system expanded rapidly helped by cheap rice imports; domestic production and procurement were also expanding rapidly. Per capita wheat imports and consumption declined. Then in 1966 through 1970 the size of the ration quota was cut in half, and the entire quota was made available free of charge. Prices rose in the open market; government procurement declined; and wheat consumption grew considerably. This was also a period of high domestic rice production and overall food consumption increased rather than decreased as a result.

In 1970 an additional paid ration quota was reintroduced at a significantly higher price. For the first time the paid portion of the rice ration cost more than wheat flour. A series of poor rice harvests combined with sharply increased world prices forced cuts in the system and drastic price increases beginning in late 1973; and for over a year wheat was also distributed through the ration system. Food intake levels declined between 1972 and 1975/76, and there is some evidence of a decline in nutrition standards.

The costs of operating the food subsidy scheme grew almost continuously with increases in population and domestic procurement. For a number of years, almost half the cost of the system to the government was covered by its profits from the sale of sugar and wheat flour at above official import prices. Low world prices for sugar and cereals during much of the 1950s and 1960s allowed the comprehensive system to operate at a sustainable net cost of approximately Rs 300 million per year in the late 1960s. But the offsetting revenue declined sharply after 1972 as a result of higher sugar and wheat prices, and the situation was further compounded in 1974 by the high world rice prices. The burden on the budget rose rapidly to intolerable levels: between 1970 and 1975 the net cost of the subsidy more than tripled. In 1978 the newly elected government sharply curtailed the system by removing the eligibility for rice distribution of approximately half of the population by the use of a means test.

Nutritional Effects

Consumer survey data used to examine utilization of the ration by different economic groups in rural, urban and estate areas and to estimate the net contribution of the ration to calorie consumption indicated that use of the ration was virtually universal, and that all segments of the community received some benefit from it. A high proportion of total cereals consumed was obtained through the public distribution system by all income groups. When converted into its cash equivalent, the value of the rice ration subsidy was equivalent to 16 percent of total income for the (lowest-income) tenth percentile of the population. This increment in income enabled them to increase consumption of a range of food products in the categories of animal products and oils and fats and to spend more for housing and clothing.

The 1969-70 socioeconomic survey data suggested that, on the average, one rupee of additional income resulted in an increased intake of 155 rice calories, 179 cereal calories, and 323 total calories. At the prevailing ration quantity and price, this translated into an increased calorie intake of only 63 calories per capita per day as a result of the ration for the average recipient (i.e., if there had been no rationing he would have eaten 63 calories less of total food). The impact was larger at the lower end of the income distribution, where the marginal propensity to spend on calories is higher. For individuals in the bottom tenth percentile of the income distribution, the effect of the ration in 1969-70 was to raise calorie intake by 115 calories per day and protein intake by three grams. The very poorest of the poor might have benefited significantly more nutritionally than the results reported above indicate. Nevertheless, this had a relatively high cost per calorie of Rs 4.10 per thousand for the added nourishment delivered.

Thus in 1969-70 only a fraction of the rice calories put through the ration system had an impact on reducing the calorie gap. The rest went to substitute for market purchases, or to raise the consumption levels of people already receiving their required levels of intake. About as much non-rationed rice was consumed as rationed rice, and the former was thought to have better quality. The poor added about two-thirds of the rationed amount to their 8 pound per month ration--on average; the rich added perhaps twice as much of the non-rationed rice.

In the 1970s cereal consumption became less stable and more closely tied to domestic production. Bad harvests in 1972, 1973, and 1975 were instrumental in leading to low consumption levels that appear to have caused some decrease in nutrition and health standards in the country. FAO estimates were 2,306 daily calories per capita in 1966-71, falling to 2,071 in 1972-77. Thus, cutbacks in the ration subsidy system beginning in 1967 seem to have left consumers more vulnerable to instability.

The benefits of the ration program were attained at a high cost to fiscal resources. It is arguable that the cost was sustainable during the 1950s and the first part of the 1960s, when it was possible to take advantage of favorable conditions in world markets, including the low prices for flour and sugar that helped offset some of the burden. But under the more difficult conditions prevailing in the 1970s, the increased costs of the system and the heavy burden it placed on the national economy made continuance of the full system much more difficult to justify. To maintain the entire system as a stabilization device to protect consumers in poor harvest years would be a very expensive proposition. The attempt since 1978 to lower overall costs by restricting ration coverage to the lower half of the population was an important step toward improving the efficiency of the system. The fact that this politically sensitive change was accomplished is a development that few would have considered possible a short time ago. It is also a commentary on Sri Lanka's administrative sophistication, itself a reflection of the successful levels of social development achieved.

Costs and Aggregate Benefits

Government cost. The most visible cost involved is the loss the government takes on the distribution of subsidized commodities plus the operating costs of the agencies involved. In the case of the domestically procured rice, the government distribution loss arises from the difference between the procurement price paid to the farmer and the price at which grain is sold to the consumer. For imported commodities, it originates in the difference between the import price converted at the official exchange rate and the ration price. When the procurement price is above the world price (at the going exchange rate), the fiscal cost rises in good crop years when more of the rationed rice is produced in Sri Lanka, and falls in bad ones when the opposite is true. The gross and net costs to the government of operating the food subsidy schemes in Sri Lanka from 1967 to 1975 appear in Table 1.

Table 1 —Gross and net fiscal food subsidies, 1967 to 1975

Year	Gross National Product	Rice Subsidy	Distribution Charge	Total Rice Subsidy	Other Food Subsidies	Sugar and Flour Profit	Net Food Subsidy With Distribution Charges
				(million Rs)			
1967	8,264	424.6	34.6[a]	459.2	3.6	260.6	202.2
1968	9,876	530.2	37.6[a]	567.8	10.9	280.5	298.2
1969	10,725	545.3	51.8[a]	597.1	14.0	288.5	322.6
1970	11,562	505.6	48.5[a]	554.1	14.5	313.5	226.5
1971	11,786	474.8	47.1[b]	521.9	4.2	286.8	239.3
1972	12,616	468.7	36.7[b]	505.4	21.6	224.8	302.2
1973	15,168	498.7	41.8[b]	540.5	25.9	201.8	364.6
1974	19,694	635.6	66.0[b]	701.6	34.6	22.6	713.7
1975	21,935	718.8	41.5[b]	760.3	11.9	−164.0	936.2

Sources: For gross national product, International Monetary Fund, *International Financial Statistics Yearbook 1979* (Washington, D.C.: IMF, 1979). The other columns are IFPRI estimates. Inter-agency transactions within the public sector have been subtracted from them.

[a] Imputed.

[b] Estimates from the Central Bank of Ceylon, *Annual Report* 1967-75 (Colombo: Central Bank of Ceylon, 1967-75).

During much of the history of the operation, income from the sale of sugar and wheat flour, particularly sugar, was enough to offset a major part of the cost of the rice subsidy. In 1969-70, for example, gains on the sale of sugar and wheat flour (Rs 285 million) were equivalent to almost 53 percent of the rice subsidy cost. Up to 1973,the net cost of the subsidy remained relatively stable. In 1973, however, the gain from wheat flour turned into a large operating loss as import prices rose. In 1974 the gross rice subsidy rose sharply with higher rice import prices, and the sugar offset dropped drastically as world sugar prices mounted. The combined result was that the net subsidy cost tripled between 1973 and 1975. The largest contribution to this increase was higher sugar prices.

The net subsidy during most of the period considered amounted to slightly more than 3 percent of the gross domestic product. However, the cost burden appears much worse when the restricted financial means of the government are taken into account. In the five-year period 1964/65 to 1968/69, the net subsidy averaged 14 percent of total current account expenditures. In the three-year period 1969/70 to 1971/72, this figure dropped to 10 percent, but jumped to 18 percent in 1975 in spite of major cutbacks. Pathmanathan estimated that the subsidy was equivalent to 36 percent of public sector capital expenditures in the 1965-70 period, and in some years exceeded 50 percent.

Thus a very large portion of the government's disposable resources had been absorbed by the subsidies. Excluding the exceedingly high cost years after 1974, the net rice subsidy in the years 1967 to 1973 was 12.5 percent of gross domestic capital formation.

Other costs. The above cost estimates understate the real burden, however. In the early 1960s exchange controls were introduced into Sri Lanka and have continued ever since with only a brief respite in the late 1960s. Under the Foreign Exchange Entitlement Certificates Scheme (FEECS), significant portions of the nonfood imports were made at the FEECS rate at a premium of 44 percent above the official exchange rate, while food imports continued to be made at the old rate. By 1972 the premium increased to 65 percent. By 1978, 60 percent of the current payments were being routed through the scheme, but imports of rice, flour and sugar were never invoiced at the FEECS rate. This means of financing the system held down the direct burden on the budget by transferring it to other segments of the economy, particularly the export sector.

In Table 2 the FEECS exchange rate was used to obtain an alternative estimate of the subsidy with rice valued at its import price converted at the FEECS rate. The subsidy to the consumer is the difference between what he would have had to pay for rice he consumed at the world price equivalent at FEEC rates and what he actually paid. By subtracting the total subsidy at the official rate from the hypothetical subsidy, an estimate of the "hidden tax cum private subsidy" involved with the operation of the program was obtained (see last column). In the crisis years of 1974 and 1975, the hidden tax involved was very large, and the amounts give a better indication than the cash subsidies of the degree to which consumers were protected by the distribution system during those years. The burden of the hidden tax was borne by exporters and by consumers of import substitutes.

Distribution of benefits. Table 2 shows the distribution of gross benefits from the rice subsidy among rice producers and consumers. The value of rice used is its import price converted at the official exchange rate (columns 1-3) and at the FEECS rate (columns 4-6). Using the official exchange rate, producers received a large proportion of the benefits in some years and 60 percent of all bene-

Table 2 —Distribution of the aggregate rice subsidy between rice producers and consumers, 1965 to 1976

	Official Exchange Rate			FEECS Exchange Rate[a]			
Year/Average	Producer Subsidy	Consumer Subsidy	Total Subsidy	Producer Subsidy	Consumer Subsidy	Total Subsidy	Private Net Transfer[b]
				(million Rs)			
1965	154	195	349	28	479	507	158
1966	185	187	373	26	476	502	129
1967	241	163	404	29	470	499	96
1968	41	479	520	−341	997	655	136
1969	205	268	473	−142	754	611	98
1970	389	88	478	−22	598	576	131
1971	387	58	445	108	468	576	132
1972	360	11	371	127	377	503	237
1973	159	304	463	−384	1,084	700	449
1974	276	438	714	−1,555	2,718	1,163	622
1975	461	135	595	−452	1,670	1,218	474
1976	744	252	492	−209	1,176	967	139
1965-73 average	236	184	431	−63	634	506	174
1965-76 average	300	165	473	−232	858	658	234

Source: IFPRI estimates.

Note: The FEECS is the Foreign Exchange Entitlement Certificate Scheme.

[a] For years before 1968, the premium of 44 percent was used.

[b] Private net transfer is equal to the total rice subsidy at the FEECS exchange rate less the total subsidy at the official exchange rate. The latter is an estimate of fiscal subsidy.

fits during the 1965-76 period. This is because the domestic procurement price was kept above the import price (at the official exchange rate) during much of the period. In 1972, when the import price was low, the consumer subsidy component was only Rs 11 million, whereas the producer subsidy was Rs 360 million. This raises serious doubt about whether the public distribution system was primarily a consumer-oriented system at all. At the FEECS rate, however, the system appears strongly biased toward consumers. Farmers were net beneficiaries in only 5 out of 12 years in which world prices were very low.

Which of the two estimates is more realistic? Because the general foreign exchange situation in Sri Lanka was not as serious before 1965, paddy farmers as well as consumers appear to have received a substantial subsidy from the scheme. In the very high world price years of 1974-76, the system was heavily biased against farmers and toward consumers. In the interim period, from 1965 to 1973, it seems reasonable to assume that the true exchange rate was somewhere between the two values. This implies that the scheme was approximately neutral or slightly favorable to rice farmers and represented a large net subsidy to consumers.

The subsidy as a proportion of income in the low-income groups, and its impact on the relative distribution of real incomes, were significant. As we have seen, the lower-income deciles received as much as 16 percent of their real incomes from the rice ration. Inclusion of the value of the ration subsidy in individual incomes lowers the Gini coefficient of income inequality from 0.29 to 0.22. The income redistribution effects are especially significant if one takes into consideration the extreme administrative and political difficulties of extending aid to low-income groups in other types of programs. It can also be argued that the income distribution effect of the food distribution system was larger than these estimates might indicate because of indirect effects on employment and returns to labor.

The system as a whole has had an important effect on the rice economy. The high guaranteed prices for rice helped to stimulate production, while the operation of the ration system played an important role in expanding the demand for rice. The rice paddy sector has been responsible for a large proportion of employment growth. According to one authority about 30 percent of the total increase in employment between 1946 and 1960 was provided by rice/paddy production. Because much of the increase in purchasing power from the ration is spent on other foodstuffs and rural products, the total employment impact in rural areas was still larger. For the bottom 30 percent of the population, 41 cents of every additional rupee of income goes to non-cereal foods, particularly meat, fish, milk, eggs, sugar, oil, nuts, and other foods that are traditionally labor-intensive activities. Another 8 cents of the rupee of increased expenditure went to housing, and 10 cents to clothing, much of which was probably labor-intensive and locally produced. The comparatively small rural-urban income differentials in Sri Lanka, no doubt, are in part a reflection of these developments.

It is not clear what role can be ascribed to the ration in this process, and to what extent the same results could have been achieved by price supports without the ration, or by other means. There seems to be little doubt that the ration played an important practical role. The need to supply the ration system provided a strong incentive to maintain the procurement system which was the basis for providing high prices for farmers. The ration helped small farmers to participate in the expansion process by permitting them to dispose of a larger quota of rice at the procurement price and get cash to purchase inputs. The price policy might not have been politically feasible without the ration. There is some question whether without the ration the domestic demand for rice would have been able to absorb the amount of rice produced domestically in the 1960s, especially toward the end of the decade. At a higher rice price to consumers, imported wheat would undoubtedly have occupied a more important place in the diet.

Discussion of Costs and Benefits

The real measure of the cost of the public food distribution system should be the impact on long-term growth. Efficiency losses due to price distortions result in lower real incomes and reduced savings. Probably more important, the drain on public resources lowers government investment in directly productive assets, while financing the budget competes for private investment resources. The measures presented earlier, such as subsidy outlay as a proportion of domestic capital formation, suggest that this impact may have been substantial. The possible impact on growth via the balance of payments constraint is difficult to assess because of the offsetting influences of the disincentive to export of the overvalued exchange rate and the contribution of increased rice production to foreign exchange saving.

A full appraisal should also take into account the positive relationship between operation of the system and economic growth. The welfare programs in general, and the rice subsidy programs in particular, should have contributed to increased productivity of investment in Sri Lanka by augmenting human capital. There is also reason to believe that raising the real incomes of the poor has been instrumental in stimulating rural development and mobilizing local resources that would otherwise have been underutilized.

Unfortunately, there seems to be no objective basis, at present, for quantifying these various effects. The long-term growth of per capita income in Sri Lanka, although not comparable with that of the most rapidly growing Asian economies, was nevertheless respectable. During the 1960s, GDP grew 4.6 percent per year. In the postwar period, however, Sri Lanka has not grown rapidly enough to prevent levels of unemployment from rising rapidly, especially among the younger age groups. And there seems to be little doubt that the rising cost of operating the food distribution system in the 1970s contributed to poor economic performance. From 1974 to 1977 gross domestic product was stagnant. This was an unusual period, however. The consequences of passing on the full rise in costs to consumers would have been socially and politically unacceptable during the crisis years, and a good case can be made that having the public system in place was instrumental in avoiding still more widespread hardship.

[Extracted from The Impact of Public Foodgrain Distribution on Food Consumption in Sri Lanka, Research Report No. 13, pp. 11-13, 47-51. Copyright© International Food Policy Research Institute, 1979.]

ENERGY

CHOICES

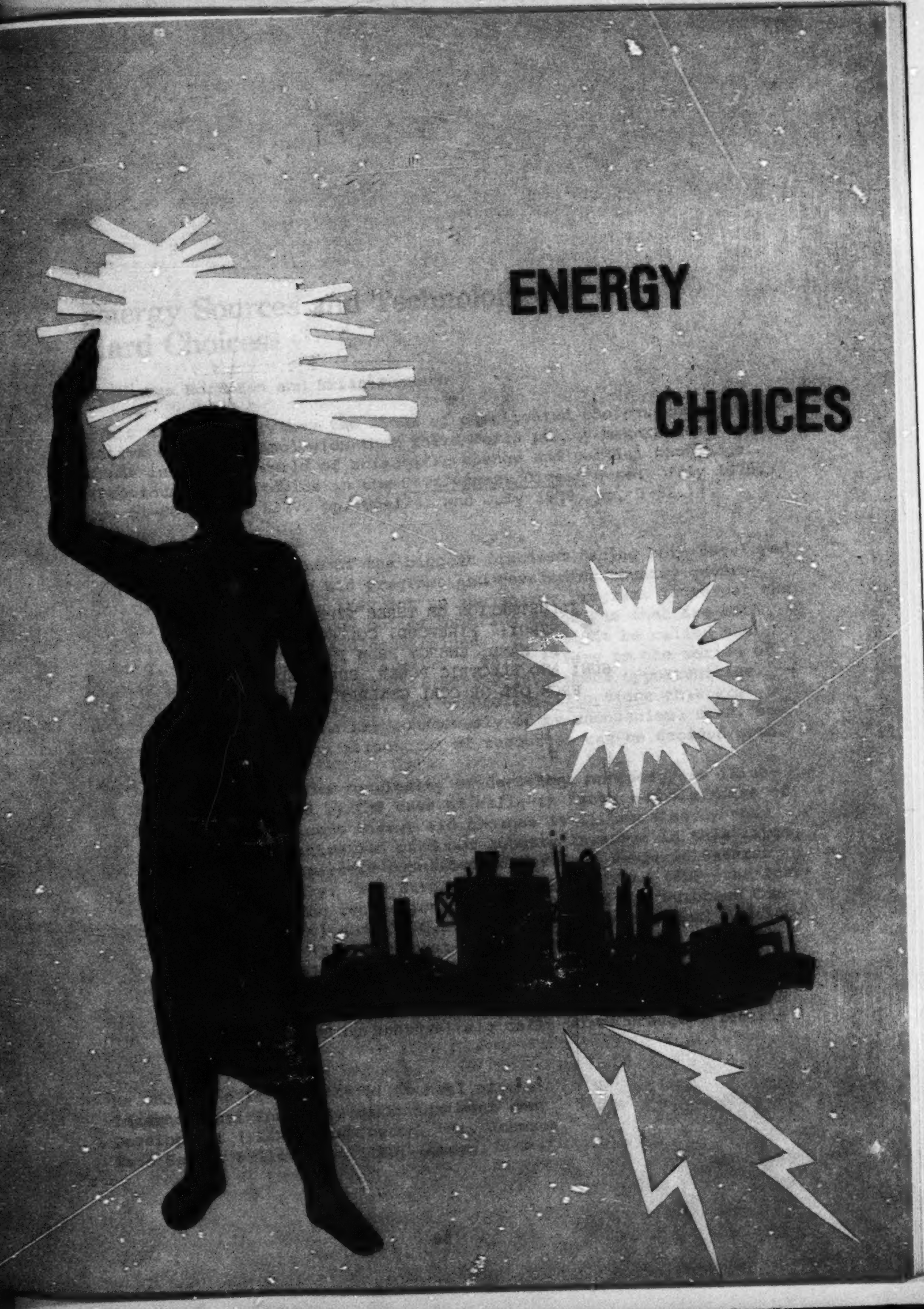

ILLUSTRATION OF THREE TYPES
OF ENERGY: FIREWOOD, COLLECTED
BY HAND; ENERGY FROM THE
SUN; AND ELECTRIC POWER, SUPPLIED
FROM OIL OR COAL GENERATORS.

Energy Sources and Technologies: Hard Choices

R. Thomas Hoffmann and Brian Johnson

[This article describes the kinds of complicated choices among alternative energy technologies that Third World policy makers must confront in today's world of scientific change and partial knowledge. (Previous energy topics in the Development Digest were: July 1976, pp. 51-86; April 1977, pp. 85-124; and July 1979, pp. 3-52.)]

One of the biggest problems facing both developed country aid programs and developing country governments as they set up new energy programs is to get the fullest use out of existing resources that are both limited and constrained. This might be called the problem of "targetry," which refers to the series of choices among alternative investment opportunities, aid subsidies, and technological options that are made, whether consciously or by unconscious bias, before any allocation of resources can be decided upon.

The complexity of decisions on energy is illustrated by the case of Mali--in fact, a whole range of difficult energy aid choices is illustrated by the concentration of donor country interest in this large, but sparsely populated, desert and semiarid Saharan country. The European Development Fund (EDF--the fast-growing concessional aid program of the European Community) and the U.S. Agency for International Development (AID) have established quite opposite strategies to help ease Mali's acute firewood and oil crisis. The EDF has set up a considerable number of solar energy demonstration projects using irrigation pumps powered by photovoltaic cells which produce electri-

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city from sunlight. The EDF's representatives in Mali want a highly visible program using the most reliable solar water pumping equipment available. They are installing relatively expensive $50,000 pumps designed for use by an entire village; and, in addition, the photovoltaic cells are costly and esoteric. The philosophy is that these very low-maintenance, trouble-free units can have a considerable impact on crop irrigation and water supply in the villages. Certainly this approach has attracted publicity and interested the Malian government.

The American energy project in Mali takes an entirely different approach, proceeding in four research and application phases over a period of several years. It includes an overall evaluation of socio-economic factors and villager preferences, as well as research on biogas and solar-powered irrigation. The project is primarily designed to gather and analyze information, rather than to have an immediate effect on the needs of villagers. The eventual goal is described as providing a technical and data foundation for future work of AID and the government, so that larger scale projects can be properly planned and executed.

Not surprisingly, each aid agency has considerable reservations about the other's approach. They appear, superficially, to be not only incompatible but mutually frustrating. But it is possible that *both* approaches are appropriate in the same country at the same time. To attack the energy problems of a country like Mali on the needed scale, political and popular support needs to be generated at every level. Hopes for a better future--the belief that problems are solvable--must be fired. This means early and tangible results. The EDF effort serves these purposes. The AID project will excite only a few energy and development planners, but it should provide the knowledge on which to base sound project ideas and fit them into a well-conceived energy planning effort. The challenge is to gather behind both approaches the momentum, conviction, and funding needed to make an appreciable difference.

The differences in approach of these two aid programs in Mali also point to one of the significant barriers to improving energy supply and use in the Third World. A false perception of choices frequently springs from the view that one type of energy is more (or less) appropriate to all the developing world needs. Thus there are advocates of nuclear power, of solar energy, of biomass, and of hydrogen fuel. These advocates concentrate on energy technologies rather than on the particular needs that energy fills. This narrowness becomes even more troublesome because of the often made, but simplistic, assumption that financial resources are somehow fungible, or transferable from expenditures on one type of energy technology to another. For example, the EDF's program in Mali is spending large sums on the most sophisticated and expensive form of solar energy, photovoltaic cells, to help a limited number of villages. It could be argued that these funds might be better spent on a much larger number of firewood projects. This might *ideally* be true, but in fact the money is only available because this type of project promotes an expanding European solar energy industry which needs subsidized markets to get off the ground. Indeed, the Malian example shows clearly how widely professional opinions can differ on ways of focusing effort and allocating investment.

This article addresses that problem of targetry. It examines present attitudes toward the availability of, and the problems with, some energy sources for which there are substantial expectations in the Third World. We do not discuss all the energy sources available for developing country application; because our focus is North-South cooperation, we concentrate on the technologies and energy sources that are most susceptible to transfer by the "North" (i.e., the industrialized aid-giving and investing countries). For example, we pay little attention here to the potential for biomass fuels, even though they are surely one of the most promising options for quite a few developing countries, because biomass programs involve relatively small capital investment and no transfer of sophisticated technology from North to South. Biomass programs can largely be carried out by Third World countries on their own, without foreign help--although there is probably a great deal of scope for technical cooperation among developing countries.

What, then, are the energy sources available to Third World countries with which Western help and advice is most likely to make a difference? We start with the energy source whose shortage has captured the world's attention.

Oil

The production potential of the great majority of countries dependent on oil imports has been explored superficially at best: enough to determine that large, easily exploitable reserves are not present, but not enough to establish whether there are smaller deposits that could make an important contribution to national energy supplies. If oil is not looked for, it certainly will not be found. The reasons for this state of affairs are discussed below, but first it is important to survey the conditions that dominate oil use in many developing countries.

Both the international and the local purchase of oil are subsidized directly or indirectly in most developing countries. Oil-importing developing countries (OIDCs) buy much of their oil on international credit that they cannot hope to repay in the forseeable future. And within many of these countries, consumer purchase of oil products, particularly kerosene, is also subsidized by the national government. The reason for this state of affairs says much about the Third World outlook on oil demand. In developed countries it is increasingly accepted that we are approaching the *end* of the oil era. But many developing countries--at least the majority of those who before 1973 had begun to anticipate the amenities of cheap energy in their lives--were only entering the oil era. Their transition into petroleum-based economies has been slowed dramatically, however, and now the question remains whether pricing policies and other incentives can be rethought quickly enough to make it feasible to avoid heavy oil dependence wherever possible.

In practice, the imperatives of immediate need are arrayed against the long-range negative pressures, particularly because oil supply and price projections have always underestimated the impact of political events. OIDCs suffer most in times of crisis; some of the poorest countries cannot meet their minimal needs when world demand soars, and the spot markets are often unavailable to them simply because of their lack of ready cash. On top of this, the Third World is not organized to allocate oil among its needy countries, a problem that the North attempted to solve for itself by creating the International Energy Agency. The distribution of OPEC oil is still carried out largely by major international oil companies, but since 1975 many smaller-scale buyers (such as refineries and traders) have dealt directly with OPEC producers. Most of the poorer countries still have almost no protection against being bypassed altogether by tankers headed for Northern ports--although in mid-1979, Saudi Arabia claimed to have earmarked a small production increase for sale exclusively in OIDCs, at the established Saudi price. Finally, oil prices in many areas of the Third World, particularly rural areas, are often several times those of the United States or Europe due to inadequate ports and roads, and transport costs can double or triple the effective price for a barrel.

The scale of recent discoveries in Mexico highlighted the possibilities for fossil fuel recovery in some developing countries. But the more significant breakthrough may be the recovery of previously unexploited or undiscovered reserves for domestic use on a comparatively small scale now that the higher oil prices could justify higher unit costs. The World Bank estimates that as many as thirty-eight oil-importing countries have reserves sufficient to make a very significant difference in the availability of oil for their own domestic consumption. Why have these reserves not been developed in the past? One of the main reasons is that international oil companies have had little incentive to carry out the expensive exploratory operations that precede production at prices prevailing earlier, and in areas of cost uncertainty. In Africa, for example, this can be attributed both to political circumstances (a general wariness of political instability and possible nationalization) and to geography (oil produced away from the coast is difficult and expensive to transport). In Latin America, on the other hand, some countries with known reserves have been extremely protective of their development. One South American country, for example, appears to have substantial undeveloped reserves. In the early seventies, concessions were leased to a dozen or so major oil companies; but the government imposed such unpalatable restrictions--such as harsh financial penalties for insufficient exploratory drilling--that most of the companies faced an absurd choice: if preparatory work indicated a halt to operations, they would either have to pay large fines or drill useless wells in difficult, largely jungle, conditions. Only recently, however, the one company that stayed on made major discoveries, and others may now be attracted to return since a new government has come to power. But five years' delay is probably costing that country millions of dollars in lost foreign exchange spent for imported oil.

Oil exploration is a risky business. Major companies usually try to spread the risk among entrepreneurs (e.g., in joint ventures) and subcontractors. But in the case of the poorest countries, this has been impossible because of the absence of the financial and scientific capability for exploration. Another significant blockage to oil development in the Third World can be traced to domestic political priorities. For example, the price of oil at the wellhead in at least one case has been tightly controlled in order to subsidize domestic prices for consumers. In addition, the national oil company has held all the best concessions for years but done little with them. These two conditions have totally blocked any serious international exploration or production activity, even though the country spends much of its export earnings on imported oil.

Of course, the greatest deterrent has been that the international price fetched before 1973 made small-scale deposits or those in remote locations entirely noncompetitive, and even known deposits were usually left in the ground by the major oil companies. In theory, a developing country could hire exploration services, buy equipment, and contract for technical services to develop its oil resources. But in practice, the challenges of such an undertaking have, till now, proved insurmountable. The major companies have not had exclusive control over oil recovery technology; their advantage has lain in concentrating on management, knowledge, capacity to hire skills, and marketing networks--capacities that give them the ability to organize and coordinate huge and integrated technical and financial operations. Now, the present and prospective price of oil may offer remarkable opportunities for creative entrepreneurship in mobilizing national or regional enterprises to explore for small oil deposits in neglected areas.

Electricity

The benefits of electricity need hardly be reiterated. There are two principal limitations on the contribution of electricity to development: cost and access. Electricity is already far too expensive to be purchased by the truly needy. It has been estimated that the costs of new electrical generating and transmission capacity to supply the equivalent of one daily barrel of oil are $37,000 for electricity produced from fossil fuel and $46,000 for nuclear or hydroelectricity. In 1977 electricity prices in developing countries were two to four times typical consumer prices in the U.S. and Europe. Despite these difficulties, electrification in both the city and the countryside is, ordinarily, a priority goal of almost all Third World countries. Three large-scale sources of electricity are available: hydroelectric, fossil fuel, and nuclear.

Hydropower. Although oil dominates the commercial energy market in the Third World, hydroelectric power projects have long known favor with development financing agencies. Many great dams were planned and built during the 1960s. By the time of the oil embargo, most of the obvious locations for large-scale projects, near population and industrial centers, had been developed. The oil price rises of the 1970s, however, have changed the economics of hydroelectric power drastically, so that higher transmission costs from remote river basins have become justifiable. A renewed interest in hydropower has surfaced in the last three years, although the lead times and construction period for hydroelectric dams are long, so that the impact has not yet been fully felt.

Changing attitudes toward rural development must, however, be taken into account in examining potential cost advantages for hydroelectric development. In the last decade development planning has come to reflect a new level of concern for the broad social and environmental consequences of development. For example, in some development assistance agencies planners now look for the most desirable development opportunities in a river basin, rather than simply assuming that a large dam in the best alternative. With the return to favor of hydroelectric power, there is a danger that environmental consequences will once again be overlooked under countervailing economic considerations. Environmental factors such as heavy siltation of a reservoir have, in the past, ruined major projects, literally undermining the initial investment. But major dam schemes are currently under construction in Africa and elsewhere that ignore almost every lesson that should have been learned from the environmental disasters associated with the large dams of the 1960s.

Decisions to plan and finance many more large dams reflect the habitual methods of major construction and engineering projects in the Western industrialized countries more than they reflect fresh analysis of the real needs of developing country populations. This in part explains why, despite a good deal of talk, so little serious attention has been given to the prospects for small hydroelectric projects. Exploitation of the remaining potential for hydroelectric production will be subjected to delay roughly in proportion to the scale of the project due to the heavy initial capital costs and the time required to prepare a hydroelectric plan for financing. Moreover, as the best remaining sites for large schemes are located in mountainous areas, generally far from population centers, transmission costs will tend to show smaller hydro schemes to further advantage.

Larger hydroelectric facilities will continue to be competitive for industrial and urban markets, and potentially very valuable as the centerpiece of the integrated agricultural and industrial development, for example, of a river basin region. However, smaller markets and isolated rural areas can be served by smaller dams. There are myriad sites in developing countries suitable for medium to very small hydro installations. In a brief review of the distribution of population in Tanzania, it was reported that a surprisingly large proportion of Tanzanians live close to year-round streams. Tanzania is generally a dry country, so it is not unreasonable to suppose the same findings are likely to be true of some other developing countries with the same conditions.

Small-scale hydro or other water-control projects need as much careful environmental attention as large barrages. Jamaica, for example, has a program for building over 200 microdams for mini-hydropower generation and irrigation; but five of the six built in the project's initial plan failed to hold water because the bedrock of the valley, which was limestone, had been insufficiently surveyed, and the floodwater simply disappeared into the porous rock. The Chinese, on the other hand, have been able to provide some of the electricity for three-quarters of their rural communes with mini-hydro generators, and there seems to be no reason why many developing countries should not achieve far more than is even contemplated at present.

Coal. Unlike much of the developed world, which largely shifted its energy dependence from coal to oil in the fifties and sixties, the developing world has always generated most of its electricity with oil-fired power plants. With the continuing rise in oil prices, however, prospects for widespread coal use seem to be on the rise. This is true in spite of widespread warnings in the scientific community over the probable impact of increased coal use on the atmosphere and the world's climate from increased carbon dioxide emission; most experts agree that these issues call for careful scrutiny. Many are convinced, nonetheless, that coal is the best available "transitional" fuel; that is, coal could be used in place of oil while renewable energy sources are being gradually developed and applied.

It certainly looks as if enough coal is *physically* available to accomplish this task. Known world coal reserves are about five times as large as known oil reserves. Most of these *known* reserves are found in the United States, the Soviet Union, and China with only 3 percent of presently known coal deposits in non-communist developing countries. In the developing world, only India has large known reserves, though Botswana, Brazil, Indonesia, and Swaziland are also thought to have substantial coal deposits. Very little of this coal in the Third World is mined and used. India mines significant amounts of it, but is joined only by Yugoslavia, the Republic of Korea, and Turkey.

Very little is really known about the potential for coal production in the Third World, primarily because there has been so little exploration for coal and, as with oil, most developing countries lack sufficiently detailed geological data. No worldwide rush has developed to locate and mine coal deposits in Third World countries, although coal is still much cheaper than oil particularly when compared in terms of the value of heat content. This situation prevails both because private companies have not been attracted by coal's price, and also because coal is more difficult and expensive to transport than oil. The United States or the Soviet Union might become major coal exporters to the Third World. That development has not begun to happen, in part because a large capital investment would be needed to switch to coal use in developing countries. Coal-fired power plants would, however, meet developing country needs for reliability and flexibility in size and they can be easily adapted to growing electricity demand without disrupting the entire distribution system. In short, the changing politics and price of oil make almost every eventuality seem within the bounds of possibility.

It would be very difficult to promote the expanded development of coal in Third World countries at the moment, because the demand to buy the coal does not exist. The World Bank has conducted one of the few reviews of constraints to coal use, and concluded that a large effort would be needed to promote longer range energy planning (allowing for the long lead times to develop coal resources) and to create the needed institutional and technical expertise, which is now almost totally missing. Finally, unlike the expanded use of some other fuels, enlarged interest in coal in the Third World may depend, in great part, on trends in the developed countries. Without an assured demand for coal, perhaps in Western Europe or Japan, there will be no export opportunities; and without research and development work in the North, there are unlikely to be any technical innovations that would be applicable in developing countries.

Nuclear power. In the early 1970s hopes for nuclear energy as a potential source of electric power in developing countries were very great. The International Atomic Energy Agency (IAEA) published *A Market Survey for Nuclear Power in Developing Countries* in 1974, which estimated that 140 reactors could be sold to Third World countries in the years 1981-1989. In May 1976 the IEA halved that estimate, and six months later officials were privately admitting that the estimate had been quartered.

Commercial nuclear power stations are operating in only six developing countries today, and in most respects nuclear power is ill suited to the foreseeable needs of almost all developing countries. Nuclear plants smaller than 200 megawatts are simply not available, yet very few developing countries have national electric grids that can accommodate plants larger than 200 megawatts, because stable electricity distribution requires that no more than 15 percent of the power come from any one generating station. Nuclear power plant construction is one of the most capital-intensive undertakings in the world today, and the return on investment lies years in the future.

In the short run, the nuclear industry fosters nearly total reliance on developed country supplies and technology. Most developing countries are now plagued by large balance of payments deficits, and they fear the political ramifications of external reliance for energy supply, yet virtually all of the equipment and the fuel for nuclear power must be imported, even by nations with indigenous uranium resources. In Iran, for example, even cement had to be imported from Germany because no cement manufacturer in Iran could provide materials that met minimum stress standards for safety purposes. A few of the most scientifically advanced developing countries, like Argentina, India, and Brazil, have advancing nuclear programs based on local capabilities. But it is clear that the immense export subsidy programs provided to nuclear plant manufacturers in the industrialized countries have been designed without particular regard to the needs or the financial predicament of much of the potential "market."

Electricity Distribution. Rural access to centrally generated electricity is still negligible in many areas. Only about 4 percent of rural Africans and 23 percent of rural Latin Americans are able to have electricity. Although most developing countries have become genuinely alarmed at the migration of rural populations to the cities, their energy distribution policies continue to encourage this trend.

The proclivities of most development aid agencies do not provide a countering influence.

Electrical power can be provided to potential rural consumers in one of three ways: central station electrical grids could be extended to reach them; small, decentralized generators using conventional fuels could be installed; or electrical systems using locally available renewable resources could be installed. As of 1975 over 80 percent of rural electricity was supplied from central station grids, for which the capital costs are much higher than for decentralized systems. The decentralized approaches improve access, but they can dramatically increase operating and maintenance costs. When the system is heavily utilized, the capital-intensive centralized approach is strongly favored over the fuel-intensive, decentralized approach. Moreover, once a grid is in place, the marginal costs of expanding service to nearby centers of demand are often relatively low. Indeed, such expansion may lower system-wide unit costs, thus serving as a strong stimulus for increasing the generating capacity.

The cost comparisons are reversed, however, for service areas remote from existing networks, due to the large costs of transmission links and "line-losses" of electricity. Rural electrification programs should not be discontinued. But transmission lines are now so expensive (in 1976 a 400-kw line cost more than $80,000 per mile) that it is questionable in a number of cases whether the benefits of centralized rural electrification would survive the rigorous economic analysis to which the benefits of decentralized, renewable energy sources are now subjected.

Centrally based power projects are, of course, essential for modern industrial growth. Most aid agency commitments to rural electrification programs have not been reconsidered, partly because of the political importance of pledges to electrify rural areas in many Third World countries. The situation in India is not atypical: the electricity that reaches villages there is rarely purchased by more than 20 percent of the households. In these circumstances, the future of traditional approaches to rural electrification, long considered so vital to agricultural productivity, has come under increasing challenge. However, commitment to alternatives has not taken hold.

Solar Energy

Much has been promised for the "technologies of the future," most of which take energy more or less directly from the sun. Is solar energy a practical solution to the energy problems of the Third World? The question is not easily answered, particularly because it is often misconstrued, but interest in the possibilities of solar energy is growing extremely rapidly in North and South alike. The Tata Energy

Research Institute in India has conducted a survey that found more than sixty-three countries and nine international organizations carrying out solar research and development programs. During the fiscal year 1979, the U.S. Department of Energy spent $500 million on solar research and increased that amount by about 50 percent in 1980. The world's second biggest solar spender, France, allocated over 260 million francs ($62 million) in 1978 to solar research and development. Finally, investment in solar energy now looks sufficiently attractive that the interest of major international companies, particularly the oil industry, has recently been awakened, so that many small solar companies have been acquired by much larger firms.

Certain solar energy applications for developing countries have clearly failed to meet the hopes of their promoters. Continuous efforts with solar cookers in various places have never really taken hold. The technology was unfamiliar, it was not possible to design it for use within existing lifestyles because cooking had to take place at an unpopular time of day and at an unaccustomed slow rate, and as a result the experiment is now generally regarded as a failure. Likewise, a French solar hot-plate company made an early effort to distribute irrigation pumps powered by solar thermal collectors through the French aid program in the Sahel and in Mexico. The problems with this heat-collecting device have been severe, particularly because the motors driven by the solar heat often break down under tough rural conditions. The director of the Latin American Office of the United Nations Environment Programme said of the Mexican project that it had been "very profitable for the French and costly to the Mexicans. It does not generate employment; there is increasing dependency on foreign technologies; it is capital-intensive; and contrary to the long life expected, in less than five years of operation, out of thirteen plants, only one is in operation."

Expectations about solar energy derive almost entirely from how one perceives its eventual applications at some point in the future, and this has been a highly controversial subject in the developed countries. Northern argumentation over the best way to develop solar energy has three consequences for potential use in the Third World. First, it means that the debate over solar energy centers on the question, "When will solar electricity be competitive with other sources?" That question, and much of the analysis that pursues it, tends to assume that competing sources of energy are *available or affordable* under Third World conditions and that they will continue to be available in the future. For example, animal muscle power to pump water may be the only alternative to solar pumps. But one must consider the environmental as well as economic costs of keeping the necessary cattle at work. Where fuelwood is almost exhausted, one must also consider the environmental and economic costs of burning dung instead of using it for fertilizer, and so forth. Likewise, extensions from electricity grids are only prohibitively costly in rural Third World areas if one assumes very low consumption levels; but if one does not assume low consumption levels, one ignores the relative poverty of the potential purchasers and the small amounts of electrical energy they may actually demand.

This leads to the second misconception that has been fostered. Sometimes costs appear exorbitant because of the level of energy use that is assumed. For example, running a flashlight on dry-cell batteries is extremely expensive in "dollars per watt," but is in fact tolerably cheap because only a couple of watts are used and flashlights are very useful for certain specific purposes. In the same way, water from solar-powered irrigation pumps may be "expensive" today; but this expense may be justified as a necessary part of an investment in research and development, in the same way that many dollars were spent on nuclear research technology before the first commercially viable reactor was linked to an electricity grid. There may be no alternative to solar-powered irrigation for the foreseeable future that is in fact affordable and available for meeting minimal water needs in remote areas. If so, then innovative demonstration and application tests to find reliable equipment are needed.

Third, solar energy projects are evaluated with methods that are often deficient with respect to Third World use. Traditional economic cost-benefit analysis assigns a value only to benefits for which a direct monetary value can be calculated. But the application of a solar energy technology in a remote area should not be compared to its theoretical competition, but to its *actual* competition. Thus, it should be a substantial "benefit" that energy will be available where it would not have been for some time to come if other sources were awaited. Another gap in the present system is the absence of field testing organized to adapt new technologies in light of local resources, activities, and energy needs. Products intended to use solar energy technology have not been designed for local conditions in poor countries, neither the power sources themselves nor solar-powered products like refrigerators. This causes good opportunities to be missed. For example, an important opportunity for international solar marketing today is in hot water heaters for the rich in tropical and semitropical countries--including the tourist industry. Not only would rich consumers benefit, but conventional fuel consumption and hence all imports would of course be reduced. The new systems would be emulated within countries as fast as the middle class could afford it. Furthermore, the wealthy in poor countries own most industries; the sooner they become familiar with domestic solar benefits, the sooner they will start adapting their manufacturing.

A final problem can be traced to the difficulties encountered by large institutions such as aid agencies in recognizing and seizing opportunities that require deviation from "business as usual." A few solar technologies for a few applications are competitive today in certain areas of the Third World where all the circumstances are right. And if the cost of photovoltaic cells drops as much by 1985 as is now widely predicted, the opportunities for this form of solar power may increase and diversify dramatically. The price of photovoltaic cells is measured in "peak watts," the output of a solar electric cell under the best possible conditions--noon on a sunny day. In 1979 a peak watt cost between $10 and $12 dollars; the 1985 price is predicted to be fifty cents. Once photovoltaic cells begin to enter the energy market, their toehold becomes an economic force that reaccelerates continued expansion of the market and continued reduction in price. The vexing problem, however, is locating the purchasing power that will unleash this cycle.

To summarize, many observers believe that there is a large potential market for solar energy technology in the Third World. Others are skeptical and stress that a market cannot exist among poor people who have no funds to pay for energy. Not only solar energy but renewable energy sources in general tend to be burdened by excessive optimism at this time, and also excessive suspicion arising from these opposed points of view. Optimism in some developing countries derives from an uncritical faith in technological advance. There is, again, no simple and obvious way ahead. But fortunately, a small but vocal minority of developers has come to advocate design, testing, demonstration, and adaptation in the region where energy technologies will be used. A substantial commitment to this process might go a long way toward dispelling another Third World suspicion--that developing countries are to be the proving ground of the North's future energy sources.

The Limits to Technological Solutions

Clearly no one energy source of technology will be right for every developing country, any more than this would be the case for an industrialized country. But aid-giving countries face a special problem in advising developing countries on how best to achieve the correct "mix" of energy sources for their particular circumstances because it can be extremely difficult to suspend developed country biases in offering this advice. It is rarely true that technological choices are obvious, so that the biases or values of whoever is choosing may be consequential.

For example, sharpening the focus of publicly financed programs must start with clear definitions of the target populations to be reached and of levels of improvement to be aimed at. A 1977 study of solar energy application in Tanzania led to the broad conclusions that each of five small-scale solar technologies that were studied was able to compete with diesel generators or extensions from the electric grid, or would be able to do so within a few years. These conclusions have been criticized because the study assumed that the villagers would consume quite low levels of energy (1 kwh per person per day). Would energy projects modeled on this and similar studies have a big enough impact, and soon enough, to make village life sufficiently attractive to villagers? The criticism of the Tanzanian study implied that legitimate Third World aspirations for more energy-intensive lives were not being taken seriously. These criticisms may well be valid if one has resources adequate to provide comprehensive help to a region or country as a whole. But if available funds are limited, as they inevitably will be, then a developing country government must choose: Will it try to have a smaller incremental effect on the lives of many villages, or a startling impact on the lives of a few?

As these judgments are made, developed countries must take care not to impose their own perceptions of energy planning on developing countries. Many Third World countries have neither the knowledge nor the management skills and planning capacities to devise an energy strategy that mobilizes an appropriate mix of alternatives. It has therefore become conventional wisdom that developing countries need better data on their energy supply and demand, better information about the energy uses of the population, more sophisticated management structures and planning capabilities, and probably more sophisticated research capability. The point is rarely made that all of these needs are endemic to a total condition of underdevelopment, and that real progress cannot be achieved in one area significantly beyond progress in others. And so, while policymakers must establish alternatives among technological approaches, they must also establish priorities among the range of institutional support and planning activities that are possible. Both types of priorities should reflect the wide variation in local conditions among developing country energy needs and energy planning.

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Wood as Fuel

U.S. National Academy of Sciences-National Research Council

[Wood serves as the major fuel to the majority of rural dwellers in the Third World. The following article discusses the properties of firewood, plantations for its production, and considerations bearing on the management of fuelwood programs; it concludes with recommendations featuring research and testing of trees for local suitability and productivity. (Note: Five articles on forestry appear in Development Digest, October 1979, pp. 1-36.)]

Advantages of Wood as a Fuel

As underground fuels become more scarce and expensive, the importance of wood is increasing dramatically. This has catapulted tree-growing into the arena of world energy production. Trees, if better managed and utilized, could rapidly increase the energy available to developing countries; and this could be done fairly inexpensively, without masses of foreign exchange or technology. In many cases using unskilled workers who are already available and under-employed in countries with severe energy shortages would be an additional benefit. Further benefits in an improved environment may be hard to quantify but are likely to be substantial.

The major concern of most governments at present is to increase and conserve energy supplies. Since energy for rural development has become more of an issue, firewood is beginning to enter the mainstream of national and international priorities and policies. Now there is new regard for foresters,

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and appreciation of the importance of their skills to a nation's present and to its future. Many government ministries other than forestry--for example, ministries of energy, agriculture, rural development, conservation, natural resources, and community services--have suddenly become interested in funding tree-growing. Development-assistance agencies have also shown a new awareness of the importance of trees. They are coming to realize, for example, that it may be pointless to worry about producing more food if there is no fuel to cook it with, and foolish to invest in costly irrigation projects if continual deforestation by firewood gatherers will silt up the dams and irrigation canals.

Both technicians and political leaders are beginning to recognize a need to integrate forestry into rural development in new ways. The U.S. Congress has directed the Agency for International Development (AID) to focus on forestry and firewood plantations in its rural development programs. The World Bank, in a recent forestry sector policy paper, announced its intention to increase its support for such activities as village woodlots, farm forestry, and environmental rehabilitation. And in Nairobi, an International Council for Research in Agroforestry has been set up, aimed at coordinating and stimulating efficient land use through combining wood and food production.

The World Bank calculates that, even with optimistic assumptions that wood-conserving stoves, biogas reactors and solar cookers will be used where available, an additional 20-25 million hectares of trees will need to be planted by the year 2000. That is 10 times more than will be achieved at the present rate of reforestation. Regional shortfalls, of course, may be more serious. According to the Club du Sahel, tree planting in the Sahelian zone of Africa must increase fiftyfold if the firewood demands for the year 2000 are to be met.

Wood can be grown where no fuel was produced before. It is renewable, and its production can be sustained. For example, the Indian neem tree, *Azadirachta indica*, introduced to the Accra Plains of Ghana early in this century, has been providing firewood to towns including Kumasi and to villages in many West African countries ever since; and the supply seems to be keeping up with demand as the neem is reseeded by bats that eat its fruit. Another example of sustained firewood production is the Paliparan area in the Philippines. In the early 1920s when *Leucaena leucocephala* was planted there, it was a green desert of the tough *Imperata* grass, a scourge of the tropics. Since then the area has been a productive energy forest, yielding 20 m^3 or more of firewood per hectare per year. Even today it is the main firewood supply for the city of Laguna and surrounding districts.

Wood can be a "self-reliant" fuel that requires little foreign exchange and is independent of the vagaries of international commerce. It does not demand a sophisticated distribution network; indeed, it is the most accessible form of energy for most rural populations in countries where it grows. It is a familiar fuel whose use requires few extension services, and it is also one of the cheapest sources of energy available. It is one of the few fuels that an individual can produce for himself. Near Mendi in Papua New Guinea, highland tribesmen plant *Casuarina oligodon* for firewood around community "long-houses" and in abandoned farmland. Although contact with this remote valley was made only in the last 20 years, today it is common to see tribesmen sitting beside the road surrounded by cords of firewood for sale (see photo below). Fuelwood can also provide export income. Kenya exports charcoal to Arabian Gulf nations, and Surinam regularly ships charcoal to northern Europe. This can, however, be a mixed blessing. Eastern Kenya, for instance, has been severely denuded by the demands for exports added to those for wood to fuel the area's cooking fires.

Papua New Guinea. Southern Highland villagers with cords of *Casuarina oligodon* wood wait beside the road for passing trucks from nearby Mendi. (N. D. Vietmeyer)

Fuelwood is not limited to household use. Large energy plantations are planned or already underway in the United States and many other countries to fuel machines such as:

- Electric generators;
- Railroad locomotives;
- Driers for fish, tobacco, lumber, grain, copra, and other agricultural products;
- Factories milling sugar, timber, or other new materials;
- Pottery, brick, charcoal, and limestone kilns; and
- Metal smelters.

The lumber and paper industries have long used by-product bark and waste to generate steam and electricity; 8 percent of Sweden's energy and 15 percent of Finland's energy is generated from wood. In the United States in 1974, more energy was generated from wood than from nuclear power. An electric generator designed to consume about 25,000 dry tons of wood fuel each month has recently been installed at the Jari Project in the Brazilian Amazon to power a pulp mill, a sawmill, and a township of over 10,000 people.

The government of the Philippines plans to support rural electrification with several wood-fueled power plants. Early in 1978 it planted an energy forest of *Leucaena leucocephala* which will be used to fuel a 75-megawatt steam power plant. A survey that covers hauling distances, plantation and cooling-water requirements, and available government reforestation areas has identified 25 potential energy plantation sites with a total area of approximately 320,000 hectares. If fully planted, these could support 19 wood-fired power plants with an overall generating capacity of 1,425 megawatts. According to the official report, a wood-fired electrical generating plant could compete economically with an oil-fired plant, and could generate an estimated net foreign exchange savings of approximately $146 million in the first 10 years of operation.

Firewood production can be good for economic development in rural areas. Growing trees for firewood can be successfully combined with the production of posts, poles, and timber. The production and sale of wood to nearby urban centers can provide many jobs and much rural cash income. It has been estimated that some 6,000 families are involved in supplying wood and charcoal to the city of Maputo in Mozambique, for example. Few other energy sources can provide and maintain such high employment.

Firewood Plantations

A logical first response to the firewood situation is to plant more trees. In theory, almost all countries have the physical resources to meet their most urgent rural firewood needs. It has been estimated that at least 75 percent of tropical land is inherently unsuited to sustained conventional agriculture, but 35 percent of the population of the tropics lives on this land. About half of it will not support vegetation of any kind. The best use of the remainder often is tree cultivation, or the simultaneous or sequential cultivation of trees with annual crops, or with the pasturing of animals. Virtually everywhere, villages have unused or misused areas on which woodlots can be planted. But there is little modern experience with growing trees explicitly for firewood, even among most foresters. Fuel production has long been considered the lowest use of wood, and foresters have traditionally cultivated trees primarily for other purposes, such as for timber and pulpwood. For these products, the species they choose to grow are not those that would be grown purely for fuel. Moreover, the yield measurements reported, the management techniques devised, and the varieties selected almost never reflect potentials for firewood production.

Firewood plantings can use species with short boles, crooked trunks, or wood that warps or splits as it dries. These features are not as detrimental to fuelwood use as to timber production. Nor is stem size. In simple cookstoves, for example, branches as small as one or two centimeters in diameter may be ideal. Thus a low shrub may prove satisfactory for village fuelwood silviculture if it grows fast and produces a dense wood that burns with intense heat. In practice, fuelwood may come both as a primary crop from fuelwood forests and as a secondary crop from timber forests.

In 1936, horticulturists transported seed of *Calliandra calothyrsus*, a small Central American shrub, from Guatemala to Indonesia. They were interested in it as a shade tree and ornamental. But Indonesians took up *Calliandra calothyrsus* as a firewood crop instead. For 25 years fuelwood plantations of *Calliandra* have been established, until they now cover more than 30,000 hectares in Java. The wood, too small for lumber, is dense, burns well, and is ideally sized for domestic cooking. It is also useful for fueling brick, tile, and lime kilns, and for copra and tobacco driers. Indonesian villagers now cultivate it widely on their own land, often intercropping with food crops. The plant's value is illustrated by the village of Toyomarto in East Java where land that was once deforested and erosion-pocked is now covered with a *Calliandra* "forest" and is fertile once more. Today the villagers sell the firewood, earning more from it than from their food crops.

Another example of shrubs grown successfully for firewood is found in South Korea. The leguminous bushes *Lespedeza bicolor* and *L. thunbergii* rapidly cover bare ground, and their long, shallow roots bind and hold down soil. Prolific root nodules provide nitrogen, and their protein-rich foliage is fed to livestock. Foresters plant *Lespedeza* species around pine seedlings to protect the soil, to provide plant nutrients, and to produce forage and firewood until the pine forest is established. The dense wood of the small stems is used for cooking fuel, and it is a well-established Korean practice to plant *Lespedeza* species along ridges as a firewood crop. It can be harvested only a year after planting, yielding 2.9 tonnes (dry weight) of firewood per hectare, or 6.1 tonnes after 2 years. The flowers are a source of honey.

In addition to fuel, woodlots in and around villages and cities can provide stable and pleasant surroundings. They provide shade. shelter, beautification, and habitats for wildlife, which in many areas are a valued food source. The plantations also reduce wind erosion, beneficially influence local temperature and humidity, and in many cases replenish and redistribute essential soil nutrients. A covering of plants slows rainfall runoff, which generally allows for greater groundwater recharge and so helps maintain year-round stream flow. Thus it decreases the likelihood of floods and the buildup of silt in reservoirs, thereby increasing the capacity and life of hydroelectric and irrigation facilities. Reforesting denuded areas is a preventive measure that decreases the severity of flooding and decreases the load of sediment entering waterways. Growing trees or shrubs within watersheds also improves the water quality of rivers and lakes and the growth of fish and other aquatic foods.

Woody plants can provide more than fuel calories. They can also be sources of:

- Vegetable oil and fruits and nuts for food;
- Edible leaves and shoots for sauces, curries, salads, and beverages;
- Honey;
- Forage for livestock and silkworms;
- Green manure for fertilizing soil;
- Tanbark for the tannin used in leather making;
- Medicines and pharmaceuticals;
- Extractives such as resins, rubber, gums, and dyes;
- Timber, lumber, posts, poles, and pulp for paper, cardboard, and construction boards; and
- Shade for pastures or plantation crops such as coffee and cacao.

Some of these uses are inimical to fuel production, but they give the tree owner more flexibility; he has the option of using some specimens perhaps for forage, while keeping others for fuel. In times of hardship, he may sacrifice some tree growth to feed his family or animals with the foliage. In some cases, dense forests can produce a great deal of burnable waste wood without a living tree being felled. In others, the owner may sell the best formed trees for timber or pulp and use the remainder for fuel.

Fuelwood Management

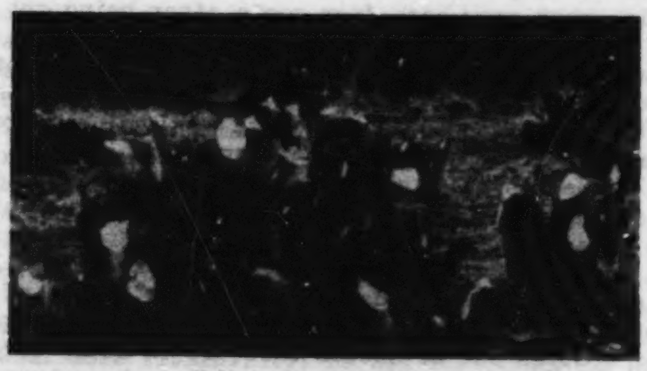
Firewood production is less dependent on silvicultural expertise than sawtimber is, and therefore can be undertaken by nonprofessionals who learn the basic techniques for their own use. Thousands of Brazilian farmers in São Paulo, Minas Gerais, and Paraná already grow eucalyptus woodlots, partly for firewood, on land generally unsuitable for agriculture. Although the cultivation of firewood species does not demand continuous professional supervision, a forest service may be needed to provide seed or planting stock of the most advantageous species, and advice for getting the trees established. Further, silvicultural practices (such as weeding and pest control) can greatly increase yields. What is sorely needed is the greater involvement of trained forestry experts in firewood production at all levels from the village woodlot to the national forest.

Rural areas can probably supply their own fuelwood from small, local plantings, while urban areas can best be supplied from concentrated large plantations, strategically located and possibly government administered. Firewood plantation, if carefully managed and protected from fire, animals, and "poachers," can be self-renewing. They are usually managed on rotations of about 10 years (much less in some moist tropical regions). The timing varies with the quality of the soil, species used, temperature, moisture available, and intensity of cultivation. Rotations of less than 5 years seem feasible in many areas, especially for those species that coppice, that is, that grow back from roots after being cut down.

Trees most likely to prove useful for fuelwood plantations are those called "pioneers," which in nature colonize deforested areas. These withstand degraded soils, exposure to wind, and drought. Many are rapid-growing legumes that fix atmospheric nitrogen. The very nature of a pioneer species endows it with adaptability, aggressiveness, and hardiness on hostile terrain. The most promising such species are often the last natives to survive repeated grazing, cutting, fire, and soil degradation. These are usually well known, available nearby, obviously adapted, and tough. Some of these species may not require nursery production and laborious transplanting. Some pioneer species can be seeded directly on site; large stands of *Leucaena leucocephala* and *Sesbania grandiflora* have been established in Southeast Asia merely by scattering seed from the air. At the same time, the aggressive vigor and adaptability of some of these pioneer species make them potential weeds.

The ability to coppice, or grow rapidly from root suckers, is exceptionally important in a firewood species. The stumps of coppicing plants do not die; instead, dormant or adventitious buds regenerate new shoots. This allows repeated harvest without the cost and effort of replanting seedlings each time. Moreover, the living roots continue to bind the soil, and a canopy of new foliage quickly develops to shield the soil surface from rain and wind and to help suppress weeds. Coppice sprouts usually grow vigorously because they are served by roots big enough to feed the former tree. The continual cropping of coppice regrowth was an established technique in Europe in Roman times, and "coppice farms" were widespread in medieval England. Today eucalyptus pulpwood plantations, in Brazil and elsewhere, are based on coppice regrowth. The first crop (grown from seedlings) is usually harvested after 7 or 8 years; subsequent harvests (the result of coppice growth) are on 5- to 6-year rotations. In Europe and the United States, large tracts of redwood, aspen, maple, beech, and ash are grown on coppice rotations.

Most woods burn, but there are properties that differentiate their relative value for fuel. Density is the most general gauge of a wood's burning quality. The heavier the wood (when dry), the greater its calorific value. The heat given off is enhanced (by about 20 percent) by the resins found in conifer woods, and by the oils and gums sometimes found in hardwoods. Green wood has a lower heating value than dry wood because energy is used in evaporating the moisture. The loss may reach 20 percent, which represents the wastage of 1 growing year in every 5. Air drying the wood yields more calories per unit of time than does tree growth in the forest, and is therefore a critical firewood conservation measure.



Coppice Farming, England. Lime *(Tilia cordata)* coppice, Groton Wood, Suffolk. (O. Rackham and J. McCann).

Some woods burn well even when green, a particularly important advantage where fuel is so urgently needed that the users are unlikely to take the time to dry their firewood. Some woods are poor fuels for use in unsophisticated stoves because they spark excessively or because their smoke is odorous, toxic, or irritating. For the foreseeable future in developing countries, fuelwood will be hand harvested. Therefore, when choosing a species for firewood plantations, one consideration should be the ease with which it can be transported. Crooked and thorny species are difficult or bulky to transport, though for local village use this may be unimportant.

Implementation

Planting fuelwood on a large scale demands social and political commitment. Decision makers in some countries, including Nepal, South Korea, the Philippines, and the Sahelian countries, are already funding national tree-growing programs. But elsewhere the pending crisis is generally not attracting the necessary financial commitment. This neglect is likely to disrupt energy supplies and lead to severe hardship in rural areas. As the pressures for fuel increase, it may lead to civil unrest and the devastation of new plantations. Research on appropriate species and management methods should start before the crisis is reached. The forest services have a crucial role to play in this race against time.

What is needed is a change in priorities in the use of trained forests *and* agronomists. Forest for fuel can be treated as just one more farm crop. This makes firewood production more suitable for developing countries with few foresters. It seems possible that existing conventional extension agents, trained as agronomists rather than foresters, will be responsible for much of the small-scale firewood production in the future.

The existing forests, however, are too important and too vulnerable to be abandoned by foresters in favor of village woodlots in the farm lands. It has been suggested that what is needed are paraprofessional "barefoot foresters" (corresponding to China's "barefoot doctors") to persuade small farmers, whose economic horizons may extend only to the next harvest, to plant trees for the future; to teach how to do it; and to introduce cook stoves that conserve firewood (see following article). Such extension services are particularly important in the case of individual and village-level fuelwood projects. Even with finances available, poor management and inadequate extension work are often critical bottlenecks. The accomplishments in South Korea have demonstrated the importance of having such trained people working at the village level.

To be successful, fuelwood programs should fit into the social and cultural framework of the local area where plantations are to be established. Projects are often doomed from the outset by religious or cultural taboos, resistance to change, attitudes toward property ownership, or government intervention. Without the commitment of local residents to the orderly management and protection of the fuelwood plantings, they are likely to fail. Projects that demand basic changes in lifestyle are more likely to fail than those that adapt to existing lifestyles and outlooks. Further, as a practical matter, fuelwood plantings are more likely to succeed if they are considered in the context of local land-use planning and local development objectives. The integration of fuelwood production with other agricultural activities can help ensure and sustain local interest; it can also cut costs and balance the development of local communities by providing them with an energy supply.

Local communities must be motivated to assume responsibility for the management of all vegetation, including trees, in their area. Forestry departments in some African countries, for example, have been producing millions of tree seedlings for distribution to villages at subsidized prices, or even free of charge, hoping to encourage individuals and communities to plant more trees. But they have met with major success only in Ethiopia, where an estimated 50,000-100,000 hectares of eucalyptus have been established--almost all of it before Ethiopia had a professional forestry service--and all planted by illiterate but self-motivated peasants.

Recommendations

1. Firewood research is vital so that the most suitable and productive tree species be found and tested for particular locations.
2. The wasteful use of available fuel should be reduced. Harvesting practices should be analyzed and reformed where needed. The testing and developing of fuel-efficient stoves, particularly ones that villagers can make themselves, is also important.
3. Conserving existing fuelwood sources is critical, for example by controlling harvesting intensity to preserve forest productivity.
4. A systematic effort should be made to identify available production areas in existing forests, wastelands, and farmlands. In each area chosen for support, foresters should prepare an inventory of the tree species found locally, noting especially the species traditionally preferred for fuel.
5. Testing tree growth in all the available production areas. Tests should include:

- Optimizing growth of volunteer trees (self-sown) of acceptable fuelwood species;
- Test planting the best native fuelwoods; and
- Test planting selected exotic species. In all trials of exotic species, local species must be included for comparison.

Characteristics of the trees that should be assessed include growth rates by volume and dry weight (of stem and branch wood), wood and chemical properties, and resistance to pests. The importance of selecting and using the best seed source within a species cannot be overemphasized.

For species that show promise, adaptability trials should be set up to determine the responses of various species to different soils, growing conditions, altitudes, latitudes, temperatures, moisture conditions, and pests. This will indicate the relative advantages and limitations of each and will provide the technical backup for pilot-sized fuelwood plantations that can serve as demonstration plots. It will also enable researchers and officials to become familiar with the species tested. These trials might also provide the germplasm to start local woodlots and firewood plantations. Comparison of experiences from such pilot plantations will provide the foundation for decisions establishing and utilizing firewood plantations and allow predictions of economic success. Most of the species selected are likely to be grown mainly in woodlots and backyards or planted to double as living fences, or shade trees in pastures, or in plantations of coffee, cacao, or other crops. Testing should therefore be done over a range of such conditions.

[Extracted from Chapter I, Firewood Crops: Shrub and Tree Species for Energy Production, National Academy Press, Washington, D.C.]

Note: Most pages of this publication are devoted to detailed descriptions of tree species most useful for firewood; lists of books and articles on selected subjects are included. This publication can be obtained without cost by writing:

Board on Science and Technology
for International Development (JH-215)
2101 Constitution Avenue
Washington, D.C. 20418, U.S.A.

Stove Design for Efficient Wood Burning

U.S. National Academy of Sciences-National
Research Council, and Volunteers in
Technical Assistance

[Compounding the problem of fuelwood scarcity is the waste from inefficient fuelwood consumption. Improvements in the designs of stoves could have a significant positive impact on fuelwood supplies if widely distributed and used. The following article discusses and illustrates some of the more promising improved designs.]

Another approach to dealing with the scarcity of fuelwood in developing countries, in addition to planting more trees and better forest management, is to reduce the demand for firewood through introduction of more efficient burning equipment. The possibilities of this approach seem particularly attractive because firewood is most scarce in those regions of the world where it is also burned most inefficiently.

Roughly 80 percent of the fuelwood consumed in developing countries is used for domestic purposes: cooking, space heating, and hot water. Many traditional cooking stoves and open fireplaces waste wood mainly because they focus the flames poorly on the cooking surface. Improving wood-burning devices seems to be one of the best ways to alleviate the twin problems of firewood scarcity and forest depletion. Often, all that is required is a very minor redesigning of existing stoves.

Improved stove models are insulated to prevent heat loss through the walls. The hearth can be

Text from a report by an ad hoc advisory panel of the Advisory Committee on Technology Innovation, Board on Science and Technology for International Development, National Academy of Sciences-National Research Council, Washington, D.C.

closed to regulate air intake and improve combustion conditions. The flow of air and hot gases through the stove is directed to concentrate heat on the cooking surface. A chimney is usually incorporated into the design to provide draft, the motive power that provides air for combustion. (If poorly designed, however, chimneys can decrease efficiency by creating excessive draft.) Cooking pots are arranged to fit properly into holes prepared for them, preventing leaks and heat loss.

Improved stoves can probably achieve an overall efficiency of between 20 and 30 percent, and they have the potential for reducing wood requirements five- to tenfold. In addition to reducing the rates of cutting of the world's trees, the wide dissemination of such stoves could reduce the time, energy, and cash that Third World women now spend acquiring fuel and cooking. It will also help eliminate smoke-filled homes, sooty hands, and eye disorders caused by smoke and fumes.

However, the claims about efficient stove designs have seldom been substantiated in unequivocal tests. Therefore, it is important that any new stove be field tested on site before it is widely promoted for local use. Perhaps the best measure of performance is the weight of fuel needed to cook a number of typical meals. This result should be compared with those of other stoves, including traditional ones.

Many factors, other than efficiency, complicate the acceptability of any cooking stove: cost, availability of materials, size and type of wood available, family size, cooking practices, and types of dishes to be prepared. These vary greatly from region to region, which means that any given stove design may not be accepted or used efficiently outside the area where it was designed.

In many cases fuelwood savings can be realized even without changes in equipment. Perhaps the best way to do this is simply to dry or season wood before burning. When burned, moist wood produces less useful heat and more smoke. To ensure that wood is dry it should be split (in the case of large logs) and stored for 6 months. Since economic pressures often prevent proper seasoning of wood, carefully designed credit schemes to ease cash flow problems might enable the populations in developing countries to save millions of tons of firewood annually.

The following pages present a pictorial survey of designs currently in use that show promise of conserving fuelwood supplies if more widely distributed. The designs shown can be constructed from locally available materials and construction requires little technical expertise, so the technologies are easily transferred.

Indian Chulah

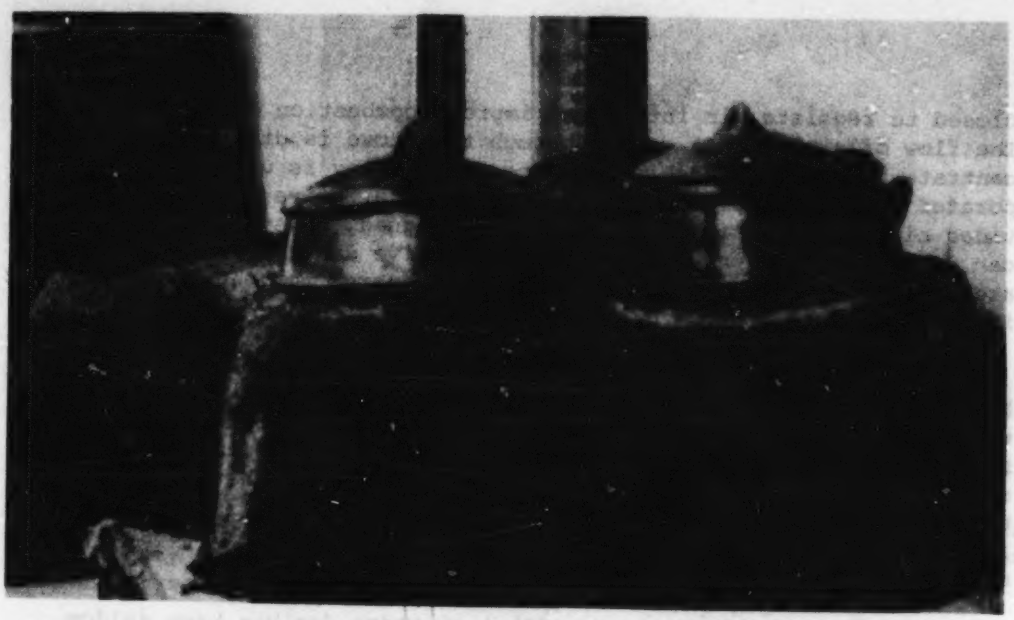


Photo: NAS

Indian Chulah. Named from the Hindi word for "cooking fireplace," the chulah has been the target of much research in India over the past 40 years. The chulah can be built of sand and clay to accommodate different sizes and numbers of cooking pots. Experiments with chulah have shown efficiencies as high as 30 percent. However, flue losses can be quite high and some tests have shown these stoves to use more fuel than their traditional counterparts that have no flues.

Ghanian Oven

Photo: NAS

Improved baking oven. In Ghana over 19,000 women operate small, wood-fired bake ovens and produce the bulk of the nation's bread. The traditional ovens are small, dome-shaped, built of sun-dried or fired-clay bricks, and take one layer of about 50 loaves. The University of Ghana Department of Nutrition and Food Science has recently found a simple way to double the stove's efficiency. Its oven has broken glass inside the base (to retain more heat) and is insulated with additional bricks. The most important modification, however, was a new construction technique that allowed the addition of a shelf so that the oven can accommodate a total of 100 loaves. This produces twice the quantity of bread for the same amount of fuelwood. (G. Campbell-Platt)

Photo: NAS

The Roti stove. A seemingly efficient cooking system has been in use in the remote Indonesian islands of Roti and Sumba. The stoves are horizontal. Pots are hung in the flames so that the heated surface is exceptionally large: no heat is wasted up a flue—there is none.

Only one description of this cooking system has ever appeared in English. It is by Captain Cook (or perhaps by Sir Joseph Banks, as it appears in the 1773 Hawkesworth edition of *Cook's Journals*). This is how he described it:

"They dig a hollow under ground, in a horizontal direction, like a rabbit burrow, about two yards long, and opening into a hole at each end, one of which is large and the other small: by the large hole the fire is put in, and the small one serves for a draught. The earth over this burrow is perforated by circular holes, which communicate with the cavity below; and in these holes are set earthen pots, generally about three to each fire, which are large in the middle, and taper towards the bottom, so that the fire acts upon a large part of their surface. Each of these pots generally contains about eight or ten gallons, and it is surprising to see with how small a quantity of fire they may be kept boiling; a palm leaf or a dry stalk, thrust in now and then, is sufficient: in this manner they boil all their victuals, and make all their syrup and sugar."

Because of the quantity of heat transferred in this cooking system, meals can be cooked using palm fronds—a very poor fuel. The system certainly seems to warrant Captain Cook's enthusiasm and it deserves testing for possible use in villages everywhere. (J.J. Fox)

Korean Ondol System

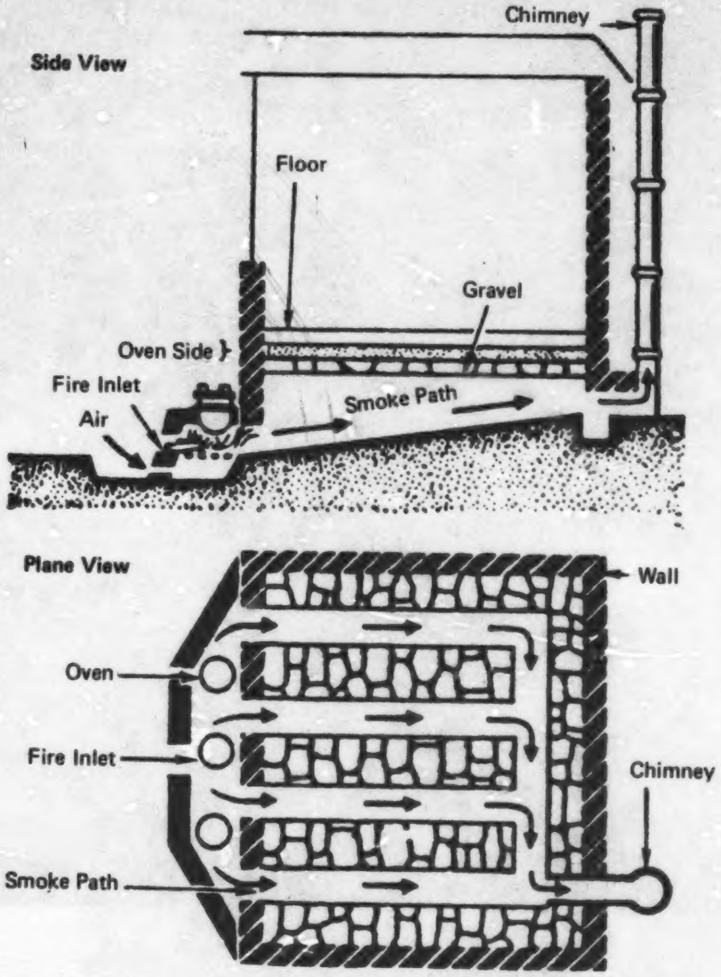
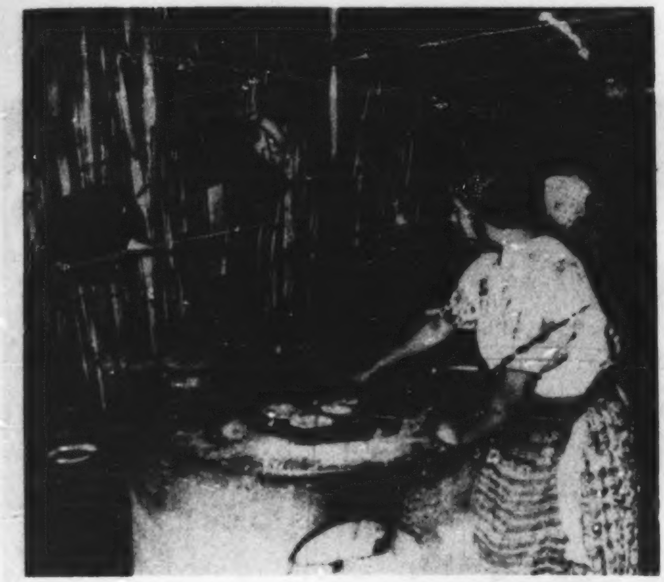

Side View
Chimney
Floor
Gravel
Oven Side
Fire Inlet
Air
Smoke Path
Plane View
Wall
Oven
Fire Inlet
Chimney
Smoke Path

Diagram: NAS

Ondol system of cooking and heating. In the Korean countryside, houses are traditionally built over a labyrinth of clay pipes packed in sand that honeycomb the foundations. Heat and smoke from the kitchen fire, or from an outside furnace, passing through these "horizontal chimneys" warms the floor and thus the rooms above. Ondols are often fired with leaves, twigs, chopped wood, brush, or hay. The double use of the heat could serve as a model for use in other locations where both cooking and heating are needed. There is some hazard of carbon monoxide poisoning with this system if the floor allows the gas to move up into the house.

Lorena Stove



The Lorena stove, developed at the Estación Experimental Choqui, Quezaltenango, Guatemala, has attracted considerable attention around the world. Constructed of a mixture of clay and sand, the stove can be built for very low cost. The stove was designed by actively involving potential users. The stove greatly reduces the amount of fuel required, is designed to accommodate traditional cooking pots, and is built almost entirely of local materials.

A cottage industry has developed around the stove. Trained stovemakers have been able to make a living by building stoves in people's homes. In this way, and a variety of other promotion mechanisms, an estimated 2,000 stoves have been built in about 2 years. The Lorena design has been replicated or adapted in West Africa, Java, Nepal, the United States, and throughout Latin America.

Photo: VITA File

Marina Garcia, promoter with the Choquí Experimental Station, Guatemala, cooking on her Lorena stove.

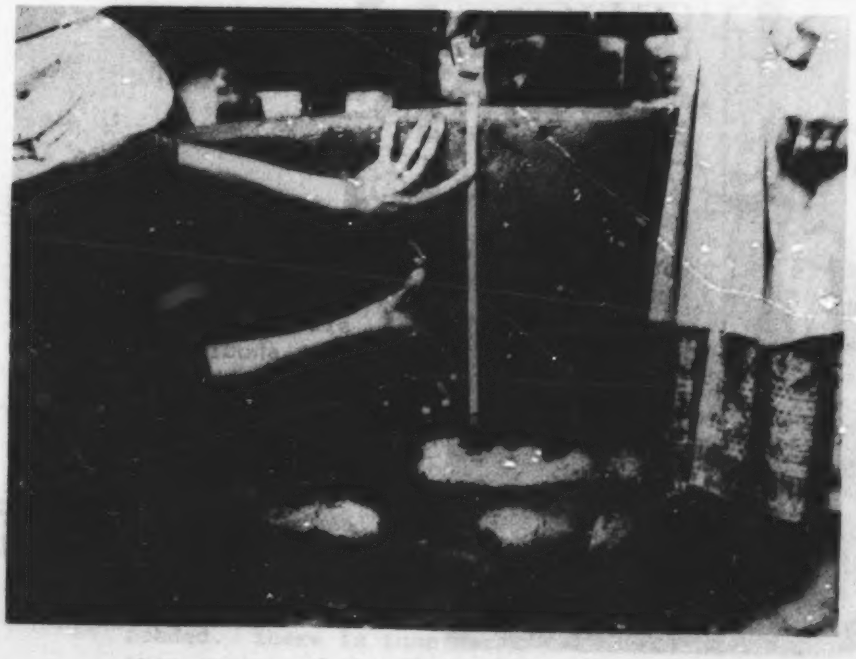
The following photographs illustrate a few of the steps in the construction of a Lorena stove.

Arranging the pots to decide on the stove's size and design. The cook should participate in the designing process.

Photo: VITA File

Packing on the mixture of sand and clay called *lorena*.

Photo: VITA File



The height of the Lorena stove depends on the height of the cook, but the layers sand-and-clay need to be at least 40 cms. down from the top of the stove.

Photo: VITA File

The pots should fit the cooking holes exactly so that heat and smoke do not escape. Rotating the pots to be used during this stage of construction indicates where the *lorena* needs to be dug away.

Photo: VITA File

Potholes and flame ducts can be excavated with spoons.

Photo: VITA File

LORENA STOVE

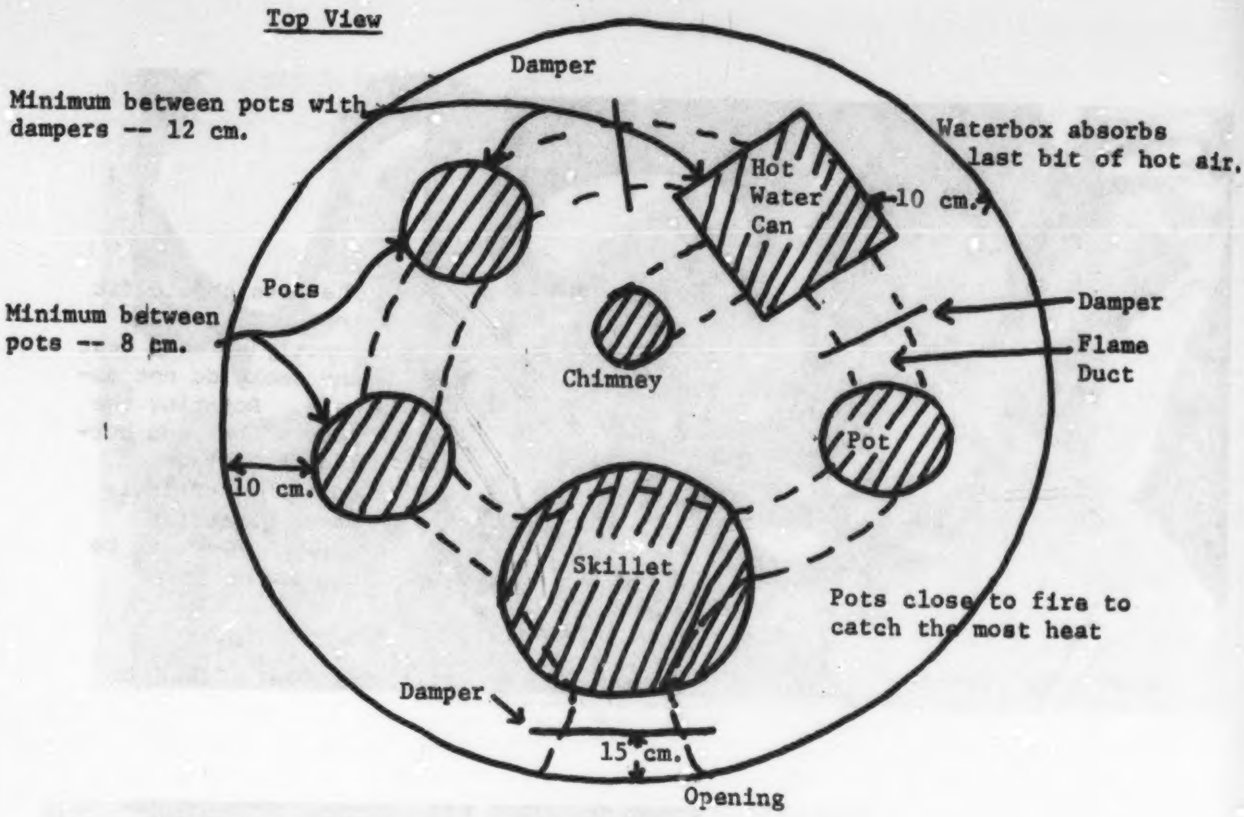

Top View
Damper
Minimum between pots with dampers -- 12 cm.
Waterbox absorbs last bit of hot air.
Hot Water Can
10 cm.
Pots
Minimum between pots -- 8 cm.
Chimney
Damper
Flame Duct
Pot
10 cm.
Skillet
Pots close to fire to catch the most heat
Damper
15 cm.
Opening

Diagram: VITA File

[Text and first four illustrations extracted from Appendix 1, Firewood Crops: Shrub and Tree Species for Energy Production, National Academy Press, Washington, D. C., 1980; Subsequent photos from "Lorena Stove Construction", (V-C-5, P1), Volunteers in Technical Assistance (VITA), Mt. Rainier, Maryland, 1981.]

Note: Further information on the use and construction of these and other woodstoves is available by writing to VITA. In addition, A Design Guide to Wood-Conserving Stoves is available at VITA for $8.95 in English, and for $12.95 in Spanish, Arabic and French.

Volunteers in Technical Assistance (VITA)
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Peat as an Energy Source

D. V. Punwani

[This article describes peat: its varieties, abundance, and distribution; its value as an energy alternative; its current and future role as an energy alternative; and the environmental and socioeconomic impacts of large-scale peat utilization. Known peat resources have been found largely in northern areas, but tropical areas have been poorly explored.]

The importance of developing alternative energy sources to augment supplies of fossil fuels is growing all over the world. Coal, oil shale, tar sands, biomass, and solar, geothermal, nuclear, and hydroelectric power have received considerable attention as alternative energy sources. One large energy resource, however, has received little attention until recently. That resource is peat. Although peat is used as an energy source in countries such as Russia, Ireland, and Finland, it is virtually unexploited in many other countries.

What is Peat?

Peat is a heterogeneous material consisting of partially decomposed vegetable matter and inorganic minerals that have accumulated in a water-saturated environment over thousands of years. The remains of many common plants have been identified in peat: trees, heath shrubs, sedges, mosses, grasses, pondweeds, reeds, cattails, algae, and ferns. Under favorable conditions most of these plants multiply rapidly, and in some places large quantities of dead

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vegetation accumulate yearly. If this dead matter is exposed to air and aerobic bacteria, decomposition occurs without formation of peat. However, when the plant debris is protected from contact with air by immersion in water, peat is formed. This peat contains a substantial portion of the carbon and hydrogen of the original organic matter. Entrapment of peat by movement of the earth's crust may lead to extremely high pressures and temperatures, and the "coalification" process proceeds to form higher ranks of coal; peat is considered the first geological step in the formation of coal beds. The sequence starts with growing vegetation and proceeds to peat, lignite, bituminous coal, semianthracite, and anthracite to meta-anthracite or graphite. That is why peat is often described as "young coal."

The "coalification" process principally involves the removal of oxygen in the form of carbon dioxide and water. As a result, the concentration of combustible material (carbon and hydrogen) increases and the remaining material has an improved heating value. Because peat is formed in a water-saturated environment, peat as it occurs in nature contains about 90 percent water. The major components of peat and other coals that affect the combustion energy are fixed carbon, volatile matter, and oxygen. A comparison of the major components of peat with those of other coals is shown in Figure 1. The increase in

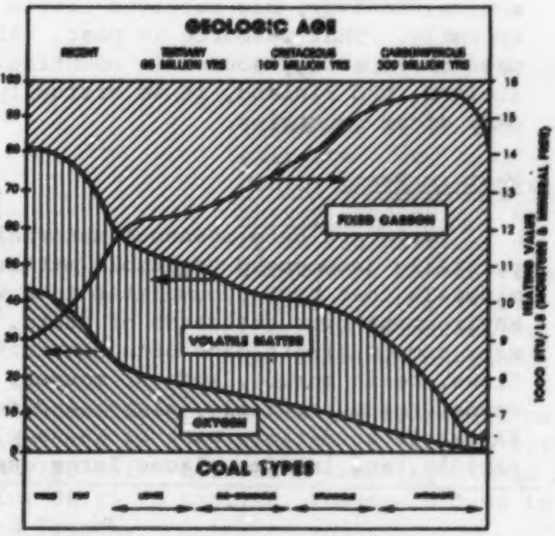

Figure 1. Comparison between peat and older coals.

Note: The line in Figure 1 which rises toward the upper right corner and has a right-pointing arrow shows heating values, measured on the right hand scale.

the fixed carbon is accompanied by reduction in volatile matter and oxygen content and generally with an increase in the fuel's heating value.

Varieties of Peat

The properties of peat vary depending upon the type of contributing vegetation and the degree of decomposition. The three most common categories are fibric (peat moss), hemic (reed-sedge), and sapric (humus).

Fibric peats are composed of sphagnum, hypnum, and other mosses. They are the least decomposed of the three types of peat and have the highest fiber content (minimum of 66.7% sphagnum moss fiber). Fibric peats also have a high water-retention capacity, low bulk density, and low ash content. Because they are the least decomposed form of peat, they have the lowest heating value on a dry and ash-free basis. Fibric peats are most desirable for horticultural use as soil conditioners, and least desirable as fuel peats for energy.

Hemic peats are formed from reeds, sedges, swamp plants, and trees. They have lower fiber content and are more decomposed than fibric peats. These peats have a higher heating value and lower water-retention capacity than fibric peats.

Sapric peats are composed of materials that have decomposed beyond botanical recognition. These peats are the oldest and most decomposed. On an ash-free basis the sapric peats have the highest energy content. The ash content of sapric peats varies from as low as 2% to as high as 60%, with high percentages reducing their energy value.

Peat Resources

Peat is a worldwide resource. A map of world peatlands is shown in Figure 2. About 95% of the world peat resources are found in Europe, the Soviet Union and North America. Estimates of peatland areas in the countries richest in peats are shown in Table 1. Surveys of peat resources throughout the world have been limited and vary considerably, partly because of differences among the methods used by various countries for reporting their peat resources. Some countries other than those listed in Table 1 might have deposits that are not large enough to substantially add to the total world resources, but are--nonetheless-significant to those countries and can still be considered valuable as energy resources. These countries include New Zealand, Argentina, Uruguay, Brazil, Paraguay, Iceland, Sri Lanka, and Burundi. Tropical areas of Africa, Indonesia, and Malaysia might also have large peat deposits.

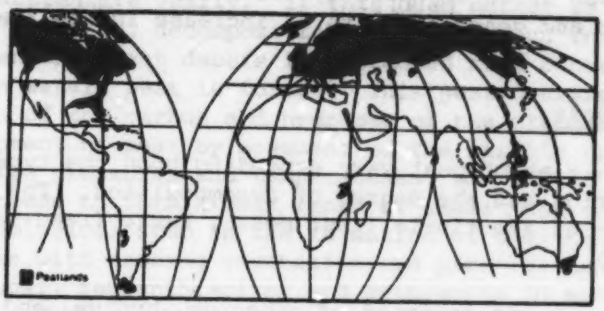

Figure 2. World peatlands.

Table 1. PROVEN RESOURCES OF PEAT

Country	Million Acres
U.S.S.R.	228.0
Canada	34.0
U.S.A.	52.6
Finland	35.6
Sweden	12.7
E-W Germany	13.1
Great Britain-Ireland	13.1
Poland	8.6
Norway	2.6
Indonesia-Malaysia	3.3
All Others	5.2
Total	408.8

Is Peat Economically Competitive?

Can peat be economically competitive with other energy alternatives even though it has a low heating value and low bulk density and may contain, in its natural state, about 90% water? Peat is now being commercially used in Russia, Ireland, and Finland. Soviet Russia has not just a few peat-fired electricity generation plants, but as many as 76, some of which have generating capacities exceeding 700 megawatts. Even though the economics of peat-fired power-generation plants in Russia is not known, it is assumed that using peat in these plants must be more economically favorable than bringing coal, oil, or gas into the areas of peat deposits. Russia is a net exporter of oil, gas, and coal; it is not experiencing a scarcity of these fuels that might otherwise force the use of peat even if it were not economically favorable.

In Ireland, peat has been used for electric power generation since 1950. About one-third of the total thermally generated electric power now is produced in peat-fired plants. Finland is by far the country most actively committed to increasing the commercial use of peat. Between 1975 and 1978, it increased its use of peat for energy tenfold. Eleven peat-fired boilers are in operation in Finland; their costs are competitive with oil-fired boilers. Because peat is a domestically available energy resource, it is preferred over oil, which must be imported.

Because newly dug peat contains about 90% water, it is impossible to burn. The heat required to evaporate the water is greater than the heat of combustion of the peat. However, if the peat moisture content can be reduced to 50% before combustion, the amount of heat required to evaporate the remaining water is only 12% of the available heat. Fortunately, the water contained in peat can be reduced to 50% moisture by exposing the wet peat to sun and air for a few days. Peat commercially harvested in Russia, Finland, and Ireland for electricity generation plants contains 35% to 55% moisture. Bechtel Power Corporation recently conducted a study for First Colony Farms on large-scale peat harvesting in the U.S. to support a 600-megawatt electricity generation plant. Results show that it is technically and economically feasible to produce peat containing 35% to 50% moisture using the air drying technique.

Peat has advantages over other coals that sometimes more than compensate for the disadvantage of being a lower grade fuel with smaller heat value per ton:

- Peat deposits are generally located in areas that have virtually no other significant fossil fuel deposits.
- Peat is not a physically hard material like coal and oil shale and it requires less sophisticated retrieval equipment.
- Peat deposits occur near the surface with little or no overburden, and the deposits are generally no deeper than 25 feet allowing greater accessibility.
- Peat is generally low in sulfur content, only about 0.2% compared with as much as 4% in some bituminous coals, reducing the pollution hazards involved in burning.
- Peat can be lower than coal in ash content.
- Peat has a high hydrogen-to-carbon ratio, (even after accounting for the hydrogen that will react with the oxygen in the peat).

Recently efforts have been made to convert peat into a gas for transmission through a pipeline, as has been done experimentally with coal. The peat gasification work conducted at the Institute of Gas Technology under the sponsorship of the U.S. Department of Energy and Minnesota Gas Company shows that in several areas, peat compares favorably with coal.

- Peat has a higher tendency to make hydrocarbon gases (natural gas components) during the initial stage of gasification (when most of the volatile matter in peat reacts with hydrogen).
- The carbon remaining in the peat after the initial gasification stage is significantly more reactive than the carbon left after initial gasification of lignite and other coals.
- Peat has higher volatile matter and lower yield of hydrocarbon gases at relatively low hydrogen partial pressures.
- During the initial gasification stage (in the presence of hydrogen) the yield of gasoline-blending feedstock and fuel oil is significantly higher.
- Relative distribution between gas and oil yield can be attained over a wider range.

All of the above factors contribute to more favorable production efficiency and economics. Recent estimates also show that conversion of peat to high Btu gas (substitute for natural gas) is competitive with conversion of other fossil fuels to synthetic high-Btu gas. Therefore, peat can be an economical energy alternative depending upon regional energy needs, location of peat deposits, cost of other energy alternatives, and scale of operation.

Environmental Impacts

As with the development of any large-scale alternative energy resource, the environmental impacts of large-scale utilization of peat must also be evaluated. Environmental systems analyses indicate that peat harvesting techniques, local hydrology and water quality, and reclaimed land-use options are interrelated and that a comprehensive plan embracing all three of these areas should be formulated. The harvesting plan needs to include control of surface and groundwater flows throughout the project area.

Peatlands are wetlands and, because some unique biological species might exist in them, it might be desirable to preserve and protect at least some of those wetlands. But one of the benefits of a large-scale peat utilization program is that harvested peatlands can be used for crop production after peat is removed--unlike some coal lands which require costly reclamation.

The Future Prospects

The potential of peat as an alternative energy source is recognized in the United States where national and state governments and private companies are funding work in the areas of improved resource estimation, improved dewatering and harvesting technology, gasification process development, and environmental and socioeconomic impact assessment. Governments of Canada, Finland, Sweden, Iceland, Burundi, and Sri Lanka are also exploring the potential of utilizing their peat resources for energy. The overall objective of the current programs is to develop technology for using peat in an economical and environmentally acceptable manner. Increased exploration could make it possible to expand the known reserves into other areas of the world which would also benefit from this source of energy.

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Cultural and Equity Constraints Conditioning Energy Usage

Elizabeth Cecelski, Joy Dunkerley and William Ramsay

[Cultural preferences and issues of equity are often overlooked by technicians, aid donors and project administrators when tackling energy problems in the poorest parts of the world. The following article points out how these oversights have affected acceptance of energy technology, and therein provides a road map of pitfalls to avoid in future programs by seeking more information on consumer preferences and local situations before undertaking costly investments.]

There is evidence of a whole range of constraints which have inhibited the adoption of or limited the benefits from new economically and technologically feasible energy systems in the past, and which may do so in the future. This can occur even when the prices of new technologies that are prohibitively high have fallen to competitive levels. This article analyzes some of the factors affecting both the use and the supply of energy by the poor in developing countries.

While not as easy to quantify or analyze as strictly technical or economic aspects, these other parameters are of interest for two related reasons. First, unquantifiable costs and benefits appear to be important in assessing the value and impacts of projects in developing countries, just as they are in developed areas. And second, we can anticipate great difficulty or failures in the adoption of new energy technologies which do not directly match the energy demands and incomes of intended users, no matter how lavish the energy assistance program. Unfortunately,

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the information on these cultural and income distribution constraints on meeting the energy needs of the poor of the developing world is sparse and unreliable. These aspects of energy needs in developing countries have rarely been the subject of field tests or pilot programs. Information has become available only incidentally after the implementation of costly programs; thus, much of the record this analysis reviews is of failure. Less is known about the successes. Why did some technologies spread and not others? More research is clearly needed; in the meantime, this review draws on the available information in analyzing the effects of different frameworks of preference.

Cultural Preferences and Energy Use

Energy use in developing areas appears heavily conditioned by "cultural" habits or "tastes," as it is in developed countries. Traditional cultural rigidities are often cited as obstacles to change in developing societies; but the real problem is quite often an inadequate valuation by analysts of the non-monetary, or not immediately visible, amenities and disamenities associated with the introduction of new technologies. Thus, various energy sources will meet the demands for a particular type of heat, for convenience, and for religious or social meaning with different degrees of success. These needs will have different priorities depending upon the framework of preferences of local populations--partially but not entirely shaped by income levels.

Energy consumption habits which seem careless to outsiders may reflect an efficiency defined by local preferences. An energy system could provide numerous non-energy services--a pleasant smoky flavor in food if charcoal is the cooking fuel, or a symbolic social center for the family if an open fire is used. These traditional demands on energy systems are not only wider than engineering definitions of "cooking" or "heating"; they can also be more specific in demanding particular energy sources for special end uses. Among the Mbere in Kenya, for example, one type of wood is preferred for carrying a light from one place to another (a slow smoldering type), another for a quick light at night to tend a crying baby, another during the rainy season (one that will not become soggy and will dry out quickly), still another for the three-day slow brewing of the local millet beer, *marua*, and so on. In addition, the seemingly inefficient cooking fire may have a much higher total systems efficiency than it appears to have (even if only Btu outputs are counted) if the embers are used for space heating, the fire for boiling water for washing, and coals for cooking.

Cooking habits: the case of solar cookers. The role of cultural preferences in energy use in cooking warrants special attention for several reasons. Cooking accounts for a large proportion of energy use by the poor, and numerous attempts have been made to improve upon the low efficiencies of traditional fuels and stoves. An open

Income and Innovations

Income levels seem to be especially influential in the acceptance of new practices, governed by the extent to which people are able and willing to bear risks. A reluctance to abandon habits tested by generations of use is often justified, given the preferences of the local population. A new strain of wheat, for example, might be vastly more productive on average but not as resistant as traditional strains to drought or insect pests, which even if infrequent would be unsupportable in their impact on a poor farmer operating at the border of subsistence. In Tanzania, where planting at a single optimal time would maximize crop yields but rainfalls are highly variable, farmers prefer to spread planting over several weeks rather than risk losing their entire crop to drought. The "Green Revolution," which introduced high yielding varieties of grains into Asia in the 1960s, provides excellent examples of many of the cultural and equity problems of introducing new technologies in developing countries.

fire is reported to have an efficiency in Btu output/input of about 10 percent or less. The large element of personal and social involvement in food preparation, however, means that cultural factors play a conspicuous part in any alteration in energy use in cooking.

Solar cookers are a beautiful example of an energy assistance idea which foundered for lack of appreciation by energy planners of the cultural, "noneconomic" preferences of users--though, as is pointed out below, a more conventional economic reason (their relatively high price) may be sufficient explanation. The parabolic reflectors developed and manufactured in India in the early 1950s failed to gain acceptance because they reportedly required radical departures from traditional methods of cooking. Cooking outdoors in sunlit areas sometimes necessitates being inconveniently distant from dwellings, and in general can increase the exposure of food to dust, flies, birds and even monkeys, and not least the cook herself to the hot tropical sun. Being able to cook only in the daytime, where cooking is traditionally done before dawn or after dusk, cooking only one thing at a time, and having to adjust mirrors have frequently been cited as additional difficulties. Unfamiliar methods of cooking may also appear dangerous.

In Mexico, the University of Wisconsin attempted over a four-year period (1958-1961) to introduce 200 metallized plastic reflectors, focusing one kilowatt on the bottom of a cooking vessel, into three rural Mexican villages. Results were mixed. One report stated that even people who did not have enough food preferred buying kerosene to cook what food they had to using the solar cookers.

The problems reported included insufficient resistance to winds and rain, having to wear sunglasses to ward off glare, and unreliability of the sunshine. It has also been suggested that the existing local knowledge of American energy technologies made Mexicans reluctant to adopt a less "modern" energy source. On the other hand, some families used the cookers up to fourteen months, even though there was no evidence of scarcity of either wood or kerosene in the area. What limited success was achieved has been attributed by some to careful planning and long-term commitment by the University. In recognition of the importance of cultural factors in the introduction of such new cooking technologies, the use of cultural anthropologists has been recommended for such attempts in future.

Improved stoves. The introduction of more efficient stoves, using biomass or commercial fuels, has often met with problems similar to those of solar cookers--requiring unfamiliar methods of cooking and new utensils, appearing dangerous, and not matching the needs of the users. Improved wood stoves have reportedly been tested unsuccessfully in Indonesia, Guatemala, and India, and in a rural development project in Tanzania by the World Bank. One approach taken to the unfamiliarity problem has been to design more efficient stoves resembling traditional models. Appropriate Science and Technology for Rural Application (ASTRA), in Bangalore, India, has made marginal alterations in the traditional *chula* which increase fuel efficiency as much as three times, and is using highly visible demonstration projects in villages, accompanied by trained staff, to introduce the new stoves.

Biogas and waste disposal practice. Solar cookers and improved stoves are not alone among energy sources in potentially conflicting with established cultural practices and preferences. Virtually any new energy source for cooking requires changes in cooking habits--for example, electricity or biogas necessitate new stoves, and sometimes changes in utensils or cooking habits. The production of biogas, in particular, involves changes in cultural practices which in many regions are as fundamental as those involved in cooking. Psychological inhibitions against the use of "night soil" (human excrement) have been reported in Korea; a reluctance to use food cooked with gas from human wastes for religious worship, and pressure from elderly parents to disconnect toilets from biogas plants have all been noted in some parts of India; and Muslim opposition to the use of pig dung in generators has been cited in Indonesia.

In South Asia, the caste system may be a particular obstacle since it involves the delegation to certain groups of activities associated with dirt and pollution. In some parts of India, for example, the *bhangi*--an untouchable caste--are responsible for herding swine along the roadsides near villages to clean up human and other wastes. *Bhangi* women are paid to gather human excreta from latrines in the homes of the more conservative villagers, where women in strict *purdah* cannot leave the house. Contact with these wastes by members of other castes would make them polluted in a religious sense.

Experience of ill health effects of handling human wastes may lie at the basis of some of these reservations. A traditionalist doctor in Bali warned, for example, that sickness would result from using biogas plant slurry as fertilizer. While cow dung is considered to have pleasant cleansing properties by Hindus, and is in fact used as an insecticide and cleanser, human feces are known in India to be disease-ridden. The quantity of human wastes is small compared to that produced by cattle, but where cattle are scarce--as in Korea or Thailand--or for a poor family owning less than three or four cattle, latrines attached to small marginally economic biogas plants could make them viable. In China, however, night soil has been used for centuries as fertilizer; and human wastes are reportedly an important source of fuel for the new methane generators.

Summary. Different frameworks of "cultural" preferences have clearly played a part in the lack of acceptance of solar cookers, more fuel-efficient stoves, and biogas plants. These tastes or habits may define the parameters of potentially suitable energy sources. In some parts of the Sudan, for example, where breakfast is at ten and dinner at four, solar cookers may be more culturally appropriate than in India. Where cow dung is traditionally used as a fuel, as in India, methane digesters based on animal wastes have been an obvious choice. The possibilities for biogas plants using pig wastes will probably be limited in predominantly Muslim areas (but not many pigs are raised in such localities). In many cases, the identification for planners of specific priority energy and other needs of users, and choices among technologies made by users, could help prevent the introduction of energy devices that will not be used. In other cases, however, education has a role to play: while the Balinese doctor cited above, for example, has good reason to believe that spreading untreated human wastes on fields may spread disease, he is unaware that the slurry (processed digester by-product) from methane digesters carries no such dangers if properly treated.

However, it is not clear from the available evidence whether "cultural" resistance in cooking habits or use of wastes is or could be *the* key factor in the acceptance of solar cookers, more fuel-efficient cooking stoves and biogas plants. Cost, and the relative abundance of alternative fuel sources, appear to have been at least as important as cultural preferences in the failure of some solar cooker experiments, and possibly with biogas as well. Widespread commercialization efforts (rather than gifts) of solar cookers or more efficient stoves intended for the poor would require drastic decreases in their initial capital costs, whether or not the cultural constraints are important. Solar cookers may compete economically with other forms of energy only in areas such as Ouagadougou, Upper Volta, where fuel is very scarce and expensive; in such cases, cooking customs could change in response to strong enough economic incentives.

If costs can be reduced, the adaptability of traditional peoples to demonstrably superior ways of performing tasks and their response to economic and other incentives should not be underestimated. For example, private bank surveys in India of the reasons given for purchasing biogas plants have found that the clean-burning gas was preferred for cooking to the smoky flame given off by cow dung, which blackens the kitchen, utensils, and clothing, and can produce serious eye infections. On the other hand, people in developing countries are probably no more willing than those in developed areas to change habits they enjoy or find convenient in order to conserve energy or use it more efficiently. The real problem unfortunately may often have been that the new energy sources in question have really not been demonstrably superior, given the framework of preferences of local populations in developing countries.

Income Distribution and Equity in Energy Supply

High cost energy sources and the poor. Some energy technologies, while within the reach of some rural income groups, may simply be too expensive in any sense for the poor to afford. In other cases, by using life-cycle costing, poor consumers might actually be able to reduce their total energy expenditures in the long run by purchasing a more energy-efficient device, but are unable to do so because of the high initial cost of the investment--even though later costs might be very small. Rural electrification appears to be an example of the former, while some new renewable energy technologies exemplify the latter problem.

The introduction of electricity in developing countries illustrates particularly well the limitations of an exceedingly flexible but relatively expensive energy source in meeting household consumption needs of low income people. Most countries have viewed electrification both as a stimulus for irrigation or other agricultural or industrial development, and as a means of raising the standard of living of the masses of people in rural areas. Yet even though subsidized, electricity has not generally proven a suitable inexpensive energy source for household consumption by the poor, especially in rural areas where the marginal costs of hookups and electricity are high due to the dispersed and small-scale nature of demand. The household devices needed to use the electric current are also costly. Thus, only about 10 percent of the people in most electrified villages in India actually have electric hookups.

Even if the poor do not use electricity directly in households, they may still benefit indirectly as street lighting allows more nighttime activities, refrigeration in stores increases the availability of fresh produce and cold drinks, and health clinics are able to keep medical supplies refrigerated. However, where incomes are very low, electricity as a consumer good, unless heavily subsidized, is likely to be limited to a small group of the relatively well off. Therefore, unless electricity is used for other, i.e., productive purposes, load factors will remain low, and the marginal costs high. An Indian survey of rural electrification in 1965 showed that growth in demand in villages slowed drastically after electric hookups were installed by some 20 percent of the population. A more recent survey in Comilla, Bangladesh, where electrification began in 1963,showed that even 15 years after the introduction of electricity, less than 5 percent of the rural population used electricity. This "saturation" level elsewhere may be greater or smaller than the 20 percent reported for India, depending upon income levels and other factors. But the possibility of such saturation should be an important consideration in allocating new investment to the expansion of existing rural electrification facilities, to the extent that electrification is intended to meet the household (rather than production) energy demand of the poor.

The newer types of energy systems tend to have low operating costs but relatively high capital costs. The Ghai solar cooker introduced in India, for example, costs $14-$18; but the traditional *chula*--a kind of earthenware bucket in which wood, dung, or charcoal is burnt and a pot set on top--has virtually zero capital cost as it is made from local clay. Although the long-term operating-plus-capital costs could possibly be lower for the Ghai cooker, life-cycle costing is often not a practicable concept for the poor, who cannot afford large expenditures even if fuel-use efficiency might thus be increased and total energy costs lowered. The same appears to be true of biogas plants, which in India cost Rs. 2,000 to 3,000 (about $260-$380); of more efficient stoves; and of reforestation programs, which necessitate both an initial investment and a significant deferral (10-15 years) of the use of fuelwood.

New energy technologies and access to other resources. A second potential equity problem is that the poor may be prevented from benefiting from new energy technologies because methods of dissemination, patterns of ownership, or local political power structures favor the relatively wealthy. The larger farmer can afford an electric hookup, which will run his tubewell and help him to increase the productivity of his fields; he can use the dung of his sufficiently numerous cattle to produce and sell methane gas; he can grow fuelwood on some of his land; and he can borrow capital against these resources. The possession of ample capital, land and cattle allows the wealthy farmer to benefit more than the lower-income population from any new technology.

In some cases, the condition of the poor may even be worsened by the introduction of energy sources susceptible to control by the wealthy. Biogas plants, for example, besides having a high capital cost, require a minimum of three to five cattle to produce the dung needed for their operation. Only wealthier farmers--in India perhaps 10 to 15 percent of the rural population--typically own that number. It has been reported that the average family in the State of Gujarat who owned a biogas plant also owned 10 hectares of land and 10 head of cattle; and the average annual income of most owners of biogas plants was $1,100.

Further problems relating to equity involve the money-pricing of goods which were previously "free" to the poor. Livestock customarily roam freely in India, providing a "free" source of dung for fuel to the poor who collect it. (It is free in the sense that the poor do not pay for dung in cash, although it has a real labor cost to them, and an opportunity cost to society as well since the dung could potentially be used as fertilizer.) Penning of cattle to collect their dung for methane generation by private owners in India could even increase energy costs to the poor; if dung assumes a monetary value as an input into a biogas plant, it is no longer "free" for the poor, who will also be unable to afford to pay for the plant's output of methane gas.

Similar equity problems may arise with fuelwood costs. In some developing areas, firewood has traditionally been virtually a free good. Deforestation, privatization of land, or institutional arrangements designed to control cutting in public preserves can deprive the poor of "free" wood, (except for their labor costs and ignoring environmental damage), forcing a shift to commercial markets. In Kenya, for example, land adjudication since 1970 has decreased the forest available to the public for cutting, as the new private owners of once communal lands have gradually restricted access by others, resulting in increasing the market sale of firewood. Commercial fuelwood plantations could have the same result.

Other decentralized energy technologies. Even apparently decentralized, "controllable" technologies such as photovoltaic cells (PVCs) may be just as inaccessible to the poor as is central grid electricity, since PVCs are not only very costly and capital-intensive, but are much too sophisticated to be manufactured in a developing country village. In one project in Mauritania, for example, a solar irrigation pump introduced by the French was controlled by two well-to-do members of the village, who sold the fresh water to poorer farmers who could previously draw free water from the well. In another example, while assisting a successful village cooperative to build water pumps and windmills in Tanzania, the head of the highly innovative Arusha Appropriate Technology Project admits that one can only hope that members of the coops--who are only a small portion of the population of the village, and not the poorest members--will use their new wealth to help others.

Conclusion

Clearly, different frameworks of preferences affect the ways energy is used, and patterns of income distribution influence the equity with which energy is supplied and the costs of providing new systems. If new energy sources are to be successfully introduced or old ones more effectively utilized, these considerations should play a much more important role in future energy assistance programs than they have in the past. Yet, it is also evident that funds are limited and time scarce; what sort of information is necessary in order to make intelligent decisions in this area?

One guide would be to start from the apparently technically and economically feasible energy sources--solar cookers in a few cases; biogas, wind and small hydro in appropriate areas; photovoltaic cells for some essential services; improved stoves, and woodlots--and try to determine what will be the role of different frameworks of preferences and the patterns of income distribution in their failures and successes, by initiating limited pilot programs. Indeed, if socioeconomic feasibility were analyzed and treated as explicitly as technical and economic feasibility, both in proposed projects and in evaluations of ongoing experiments, a great deal would be added to the store of knowledge from the past in this area as well as from future experiments.

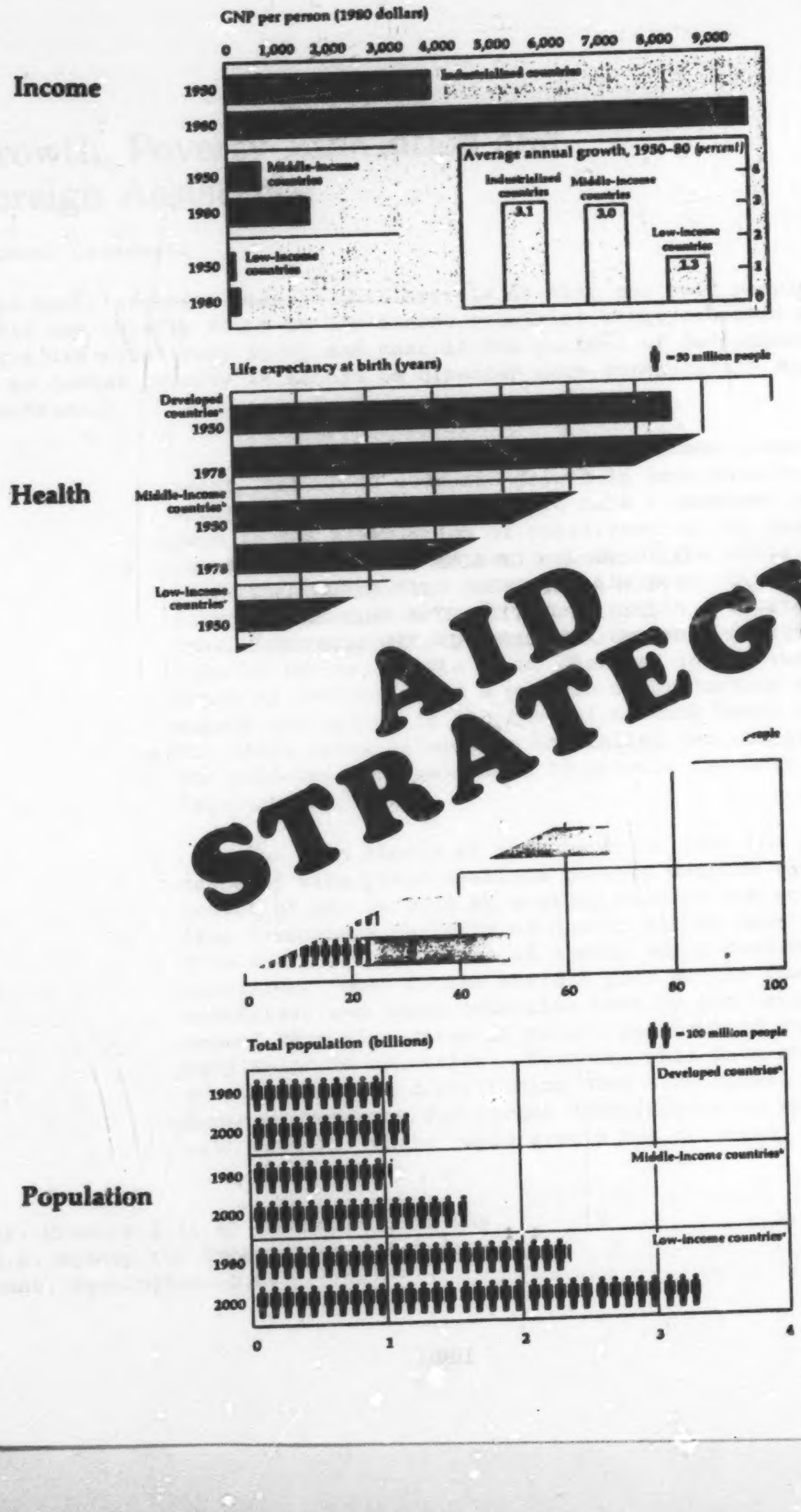
One reason for difficulties, however, may lie in measuring the energy demand of the poor as an abstract quantity. Needs as assessed by outside observation may not match the present or latent priorities of intended consumers. The attempt to obtain for planners a definition of energy and other demands by local populations themselves--if feasible--would provide a more helpful framework for considering supply alternatives. The most successful energy technologies introduced might then appear to be those requiring only marginal alterations in current practices and institutions; more efficient stoves that cook and look like traditional models may have more promise than solar cookers, for example.

On the other hand, some clearly advantageous energy sources--such as electricity and kerosene--appear to have had little difficulty in gaining acceptance where they have been affordable, even though they required radical changes in behavior initially. The factors involved in the adoption of these new technologies should be investigated.

Existing income distributions and ownership patterns clearly influence the benefits to the poor of new energy systems, first because even investments that are "economic" in the long-term may not be affordable to the poor, and second because new energy sources, like other resources such as capital and land, are likely to be more easily taken up and controlled by the relatively wealthy. More careful attention needs to be paid to mechanisms such as low cost, credit, or subsidies that would allow more of the poor to benefit from the introduction of new energy sources, particularly where a formerly "free" good becomes priced as a result. While the poor will always have less access to resources than others simply because they are poor, it is worthwhile to find out whether some energy systems may be inherently inimical or beneficial to distributional equity, or whether they are vulnerable to local controls in the same ways as other resources.

[Extracted from Chapter IV, Household Energy and the Poor in the Third World. Research Paper R-15, Resources for the Future, Washington, D.C. Copyright© Resources for the Future, 1979.]

AID STRATEGY



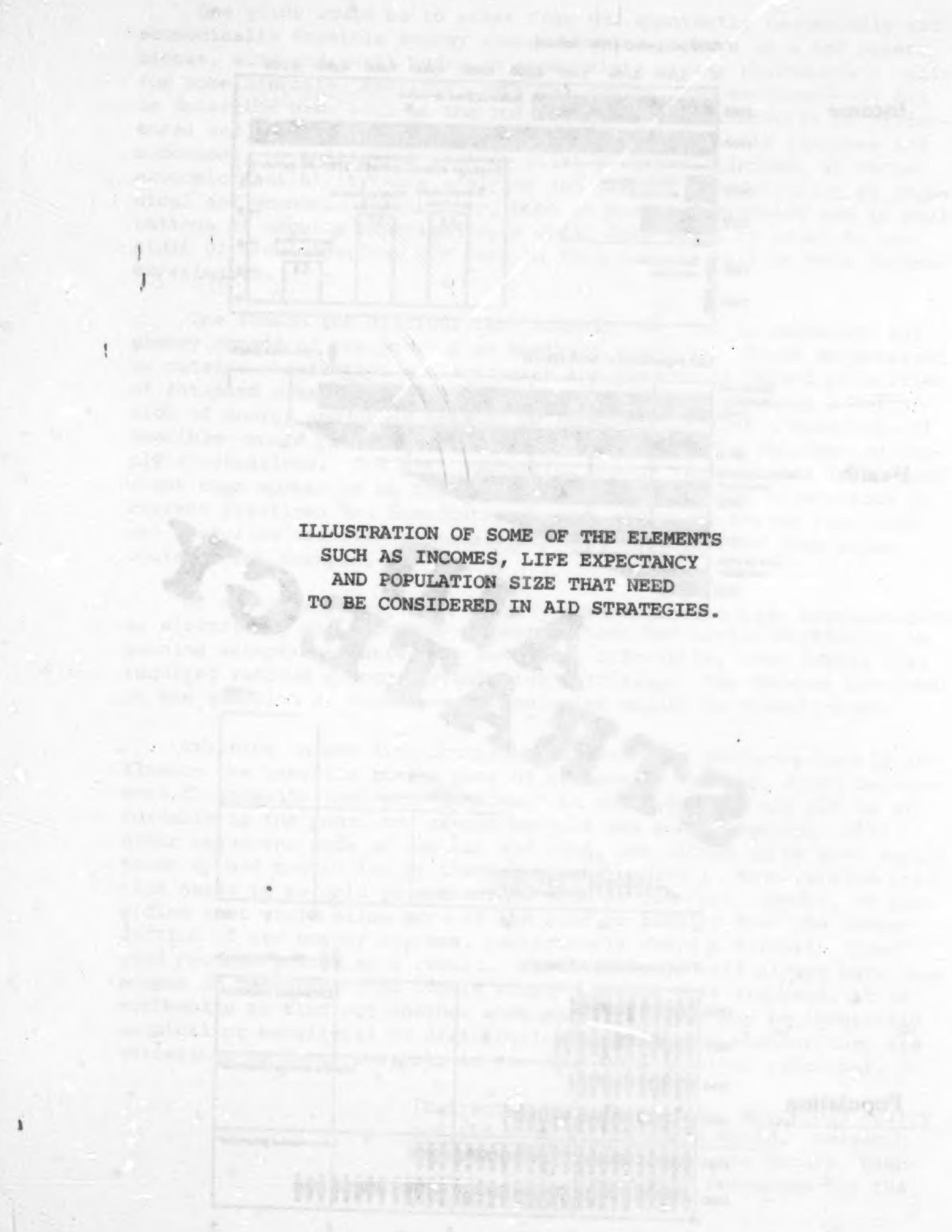


ILLUSTRATION OF SOME OF THE ELEMENTS
SUCH AS INCOMES, LIFE EXPECTANCY
AND POPULATION SIZE THAT NEED
TO BE CONSIDERED IN AID STRATEGIES.

Growth, Poverty Alleviation and Foreign Assistance

Michael Crosswell

[The basic argument made in this article is that the poor people of world are chiefly found in low-income countries where economic growth rates are relatively slow, and that if the purpose of development aid is to combat poverty it should be directed more consistently to such countries.]

Most of the literature on basic human needs asserts that rapid economic growth in less developed countries (LDCs) has failed to make a substantial impact in the alleviation of their poverty, in the enhanced satisfaction of basic needs of the whole population. This failure has typically been attributed to disequalizing patterns of growth within countries; these have allegedly generated a worsened distribution of income, little or no increase in absolute incomes of the poor, and a pattern of production and supply ill suited to the task of meeting basic needs. The basic needs literature has called for changes in the patterns of development to provide for more "equitable growth."

The main thesis of this paper is that the persistence of widespread absolute poverty despite rapid growth of GNP in LDCs as a group results not so much from inadequate patterns of growth within countries as from the uneven patterns of growth among developing countries. Most of the world's poor are in low-income countries; and these countries have by and large experienced very slow rates of growth as compared with the middle-income countries. Further, what data exist on trends in income distribution over time reveal no predominant tendency for income distribution to worsen with growth. Where rapid growth has occurred, it has

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almost always resulted in a reduced incidence of poverty. This certainly does not mean that the current emphasis on basic human needs is misplaced; the development community faces a pressing need to alleviate world poverty. Nor does it imply that intra-country patterns of growth are unimportant. It does, however, point to a dimension of the basic needs problem that has been relatively neglected, particularly by aid donors. For it turns out that, while most of the developing world's poverty problem is heavily concentrated in low-income countries, the bulk of concessional foreign assistance has been directed primarily toward those in the middle-income range.

The first section of this paper takes up an analysis of the distribution of poverty among groups of countries, classified according to per capita income. The main findings are that over 80 percent of the world's poor are in low-income countries--those with per capita incomes in 1977 at or below $300; about half of the population in this group is poor. Countries with per capita incomes above $450 account for less than 10 percent of LDC poor, and the incidence of poverty in this group is only about 14 percent. The next section of the paper examines critically the proposition that rapid growth has failed to make a substantial impact on absolute poverty because of adverse trends in income distribution as growth proceeds. While cross-section data lend some support to this latter proposition, time-series data do not. Empirical studies of a number of developing countries suggest that rapid growth has typically been associated with reductions in absolute poverty.

The third section of the paper draws implications for donors of concessional foreign assistance. An examination of the distribution of Official Development Assistance (ODA) among groups of countries reveals that the low-income countries--with over 80 percent of LDC poor and over 60 percent of the total LDC population--received less than 45 percent of ODA commitments. In contrast the group of countries with per capita incomes above $450--which account for less than 10 percent of the poor and about one-quarter of the total population--received over 35 percent of ODA commitments. These results lead to a discussion of allocation models that donors might use to effect a redistribution of ODA along patterns that would be more consistent with the objective of achieving substantial reductions in LDC poverty by the end of the century. The final section of the paper reviews some of the evidence on the relationship between foreign assistance and growth. Although this evidence is mixed, it suggests that increased foreign assistance to low-income countries could make a substantial contribution to more rapid growth over the next ten to twenty years.

I. The Distribution of Poverty Among Countries

Estimates for 36 developing countries. The methodology used here for determining the distribution of poverty among countries is based on the work of Ahluwalia, Carter and Chenery (Journal of Development Economics, September 1979). They in turn used as a point of departure estimates of real GDP per capita published by Kravis, Heston, and Summers (The Economic Journal, June 1978). The Kravis paper is motivated by the observation that the purchasing power of a dollar varies considerably from country to country at any given time. Accordingly, a comparison between two countries in terms of per capita income measured in dollars using conventional exchange rates does not give an accurate picture of one country's average real income relative to another's, nor of where a poverty line defined in dollar values would fall. The Kravis estimates of real GDP per capita represent an effort to deal with these disparities using an *exchange rate deviation index* that measures the extent to which nominal comparisons with income in the United States misstate real comparisons. For instance, the observed Kravis index value for India is 3.34, indicating (roughly) that a dollar in India in 1970 could purchase the equivalent of $3.34 in the United States in the same year. The deviation index values for 1970 range from 1.22 for Germany up to the 3.34 Indian value.

Ahluwalia, Carter and Chenery (abbreviated to ACC) used these Kravis adjustments in estimating percentages of population in absolute poverty for thirty-six developing countries. They started with 1970 per capita GDP figures in nominal terms measured in dollars on the basis of conventional foreign exchange rates, and converted these to dollars of uniform purchasing power (ICP dollars) using the Kravis index values. Thus, for Indonesia, real per capita GDP in ICP dollars was 3.10 times the level of nominal GDP per capita. ACC then posit a poverty line of 200 ICP dollars, which is about the income level of the 46th percentile of income recipients in India. This income level would be approximately adequate to ensure a daily supply of 2,250 calories in India. This poverty line is essentially a South Asian standard, which is conservative in the sense of yielding estimates that understate the extent of the poverty problem by standards that might be appropriate for more affluent developing countries.

Given this poverty line and the estimates of real per capita income (in ICP dollars), ACC use information on income distribution to estimate the percentage of population in absolute poverty for the other thirty-five developing countries. Their sample size was limited by availability of income distribution data, but the sample accounts for about 80 percent of developing country populations (excluding China). The ACC estimates of poverty incidence using purchasing power adjustments range from over 60 percent poor in Bangladesh, Ethiopia and Burma, down to under 10 percent in Taiwan, Argentina, Yugoslavia and Venezuela.

Estimates for 68 other developing countries. The next task is to estimate the incidence of poverty for some sixty-eight other countries for which reliable information on income distribution was not available. The basis for the estimates is the following regression equation, which was calculated using the ACC results for 36 countries just described.

$$\begin{array}{llcccc} (1) & & PPK = 75.70 & - .094(PCIK) & + .000030 & (PCIK)^2 \\ & \text{t-values} & (18.58) & (-\ 10.32) & (7.33) & \end{array}$$

$$R^2 = .85$$

PPK = Percentage of population in Poverty, using Kravis adjustment of money values.

PCIK = Per Capita Income, with Kravis adjustment.

This equation indicates that most of the variation (85%) in percentages of population in absolute poverty (PPK) as estimated by ACC can be largely explained by levels of per capita income adjusted for purchasing power (PCIK). The missing information, of course, is the distribution of income. Surprisingly, including a single income distribution variable--the estimated share in total national income of the lowest 40 percent of income recipients (YD)--improves the explanatory power of the equation only slightly ($R^2 = .87$), and alters the value of each of the other coefficients by only about 8 percent.

The inclusion of the squared term $(PCIK)^2$ allows for the possibility that the effect of increases in real per capita income on the incidence of poverty becomes weaker as the percentage of the population in poverty declines. This makes sense, considering that an increase of $100 in per capita income would have a major effect on poverty in a very low-income country such as Ethiopia, where two-thirds of the people are poor, which it would not have in richer countries with smaller percentages.

The distribution of poverty among countries. Table 1 presents data on groups of countries determined by their 1977 per capita GNP, giving the percentages of poverty within each income group and the portion of total poverty accounted for by each group. The most striking result of this grouping of countries is the high concentration of total poverty in the poorer countries of the sample. About one-half of the countries in the sample have per capita incomes at or below $450; collectively they account for over 90 percent of total poverty in the sample. The bulk of this poverty is in countries with per capita income at or below $300, and a sizable portion is in India alone. This concentration of LDC poverty reflects not only low average levels of income, but also the fact that countries at or below $300 comprise over 60 percent of the total population under consideration. The second important feature of the data is the fairly steady decline in incidence of poverty as per capita income increases (second column).

Table 1: THE DISTRIBUTION OF POVERTY AMONG INCOME-LEVEL GROUPS OF DEVELOPING COUNTRIES

Country Group: 1977 Per Capita GNP	1977 Population (millions)	% Poor	Poor Population (millions)	Percent of Total Poor
Less than $150 (14 countries)	219.1	62	135.8	17.4
India - $150 (1 country)	631.7	46	290.6	37.2
$150 - $300 (24 countries)	401.3	51	203.6	26.1
$301 - $450 (13 countries)	245.9	31	76.6	9.8
$451 - $1200 (28 countries)	326.4	15	49.0	6.2
$1201 - $4800 (22 countries)	208.5	12	24.9	3.2
Total (102 countries)	2032.9	38	780.6	99.9

SOURCE: Country groupings are based on 1977 per capita GNP figures from the World Development Report 1979, or in a few cases from the 1979 World Bank Atlas. Population figures are from the 1979 World Bank Atlas.

II. Relationships of Economic Growth to Poverty Alleviation

Much of the discussion of basic needs has been motivated by a perception that economic growth has failed--that significant increases in GNP have not resulted in substantial reductions in world poverty. For instance, the World Bank/Sussex volume, Redistribution With Growth (Chenery et al., editors, Oxford University Press, 1974) was introduced with the statement: "It is now clear that more than a decade of rapid growth in underdeveloped countries has been of little or no benefit to perhaps a third of their population," (p. iii). In part, this view stems from the aggregate data on LDC performance, which demonstrate rapid growth in LDCs as a group but only slow progress in reducing poverty. Between 1960 and 1976, per capita GNP in developing countries grew at an average annual rate of 3.7 percent. At the same time the ILO estimates that between 1963 and 1972 the number of seriously poor in LDCs increased from 1.1 to 1.2 billion, tion, which was calculated using the ACC results for 36 countries just described.

$$(1) \qquad PPK = \underset{(18.58)}{75.70} - \underset{(-\,10.32)}{.094(PCIK)} + \underset{(7.33)}{.000030}\,(PCIK)^2$$

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and the incidence of poverty fell only slightly, from 73 percent of LDC populations to 67 percent.

The bulk of the analysis of the evident failure of LDC growth to alleviate LDC poverty has attributed this failure mainly to patterns of growth *within* countries. These patterns are inferred from the tendency for the distribution of income to become more unequal as one moves from low to middle income countries, so that the impact of per capita income growth on the poor has been assumed to be either negative or at best only weakly positive.

With attention focused on growth patterns within countries, there has been relative neglect until recently of the pattern of growth *among* countries as perhaps the key factor underlying the slow pace of poverty alleviation. Yet the following data on growth rates of per capita income for LDCs grouped by income level, in conjunction with the estimates of the distribution of LDC poverty presented earlier, suggest that arguments about the failure of rapid growth to alleviate poverty need to be carefully examined. Table 2 indicates that in the group of countries where most of the world's poor subsist--the low-income countries--economic growth has on average been very slow. In contrast, middle-income countries, where both the incidence and numbers of poor are relatively low, have been growing rapidly. If anything, these data point to the success rather than failure of rapid growth in alleviating poverty.

Table 2: GROWTH AND POVERTY

Country Group	Average Per Capital Income Level ($)	Incidence of Poverty (%)	Share of LDC Poverty (%)	Average Annual Per Capita GDP Growth (%)	
				1960-70	1970-77
Low-Income	170	50	81	1.5	0.9
Middle-Income	1,140	19	19	3.7	3.5

SOURCE: World Development Report 1979 for data on income levels and growth rates. "Low-income" refers to countries at or below $300 (1977 prices). Averages are weighted averages.

Other evidence of the impact of growth on poverty alleviation. We now proceed to examine other kinds of data that shed a different light on the relations between growth and poverty. We begin with the data on per capita income, the income share of the lowest 40 percent, and estimates of the incidence of poverty derived by Ahluwalia, Carter and Chenery in the study presented earlier. The regression equation cited above indicated that, for the sample as a whole, 85% of the variation in poverty incidence could be explained by differences in the level of real per capita income. Our concern at this point is mainly with the effect of growth on poverty in the low-income countries in particular. Therefore, the following equation was tested for the 25 lowest income countries of the ACC sample, using data on 1975 per capita income (PCI) measured in 1970 prices and at official exchange rates, and on income shares of the lowest 40 percent of income recipients (YD).

$$\begin{array}{llll} \text{(2)} & \text{Log PPK} = 14.80 & - 1.43 \text{ Log PCI} & - 1.53 \text{ Log YD} \\ \text{t-values} & (20.47) & (-20.30) & (-9.05) \\ & & & R^2 = .95 \end{array}$$

PPK = Percentage of population who are below the Poverty line, with Kravis adjustment.

PCI = Per Capita Income (not adjusted)

YD = Percentage of total income received by the poorest 40% of the population.

As the variables are all incorporated in logarithmic form, the coefficients are equivalent to elasticities: this equation indicates that an increase of 1 percent in per capita income will reduce the incidence of poverty by 1.43 percent (not percentage points) if income distribution remains unchanged. Consider a country with a per capita income of $100 (1970 prices), in which 15 percent of income accrues to the lowest 40 percent of recipients. If per capita income increases at constant prices to $110, the incidence of poverty would tend to decline from 58.6 to 51.1 percent. With a doubling of per capita income, the incidence of poverty would fall below 22 percent, as long as the income share of the lowest 40 percent remained unchanged. This equation explains 95 percent of the variation in the sample.

The regression results also reveal the importance of variations in income distribution as represented by the share of the lowest 40 percent of income recipients (YD). For instance, at a per capita income level of $100 the percentage in poverty will be about 58.6 percent with an income share of 15 percent, but will rise to 73 percent if this share falls to 13. The effect on the incidence of poverty of doubling of per capita income from $100 to $200 would be completely nullified if the share of the lowest 40 percent fell from 15 to 7.8 percent.

What changes in income distribution can one reasonably expect to accompany growth? Ahluwalia's investigation of the "Kuznets Curve" (M. S. Ahluwahlia, Journal of Development Economics, September 1976; see also Development Digest, April 1978, illustration p. 101 and article pp. 103-124) suggests that the income share of the lowest 40 percent tends to decline sharply as one moves from the low-income countries to the middle-income countries. However, this tendency is not very consistent for his sample of forty developing countries; his regression equation explains only about 25% of the observed variation in the share of the lowest 40 percent. So other factors are also influencing this share, and they may counteract or even reverse the tendency to decline. Indeed, much of the discussion of the basic needs approach is explicitly directed towards finding patterns of growth that would lead to an improved (i.e., more equal) distribution of income.

Ahluwalia's estimates have been criticized for their exclusive reliance on cross-country observations (that is, comparisons among single year values from different countries). New evidence on trends in income distribution over time, rather than across countries, casts doubt on the proposition that distribution tends to worsen with growth in per capita income up to a point (to a middle income level), and then to improve, that is, to become more equal as incomes rise to higher levels. Gary Fields has investigated the experience of thirteen countries for which data on changes in income distribution over time appear to be reliable (Poverty, Inequality and Development, Cambridge University Press, 1980). His findings indicate that inequality, measured by the Gini coefficient, rose in seven countries (Argentina, Bangladesh, Brazil, El Salvador, Mexico, the Philippines and Puerto Rico) but declined in five (Costa Rica, Pakistan, Singapore, Sri Lanka and Taiwan) and probably declined in India as well. Fields concludes that no general relationship between changing inequality on the one hand and either initial level of inequality, level of GNP, or its rate of growth on the other has been found.

The study by Ahluwalia, Carter, and Chenery noted earlier also contains time series data on income distribution for a group of twelve countries. The ACC data indicate that in four countries there were substantial improvements in the income share of the lowest 60 percent; (Sri Lanka, Costa Rica, Colombia and Turkey); in five countries the share changed very little; (negligible changes in Yugoslavia, the Philippines, and Peru; a slight improvement in Taiwan and a slight decline in Korea); and in three countries there was a significant decline (India, Mexico, and Brazil).

To evaluate the Kuznets Curve hypothesis, we may look at per capita income levels of the eighteen countries covered by the two studies during the periods over which the time trends in income distribution were observed. We will take as a mid-point around which the curve changes direction the per capita income level of $670 in 1977 prices. For countries with relatively low incomes (below $670) over the period in question, income distribution should have worsened with growth. This occurred in El Salvador; but in other low-income countries, income distribution improved (Sri Lanka, Pakistan), or remained unchanged (Peru) with growth. In other cases the evidence on income distribution was mixed (India, Philippines); or growth did not take place (Bangladesh, where per capita income declined). In high-income countries (above $670), income distribution should have improved with growth. This occurred in three cases (Costa Rica, Singapore, and Turkey); but in four cases income distribution worsened (Brazil, Mexico, Argentina, Puerto Rico) or was substantially unchanged (Yugoslavia). Finally, there were three countries (Korea, Taiwan, Colombia) that moved from the low-income side of $670 to the high income side; income distribution improved in Colombia and did not change significantly in Korea and Taiwan. Taken together, these results do not support the proposition that income distribution tends to worsen with growth up to a point, and then improves as incomes rise further.

More positively, these findings give grounds for cautious optimism about the effects of trends in income distribution on the scope for alleviation of poverty, and indicate regional differences. LDC poverty is heavily concentrated in Asia, and secondarily in Africa. Of the five countries in which experience has been clearly that of positive growth combined with significant increases in inequality, all are in Latin America, and only one (El Salvador) would have fallen in the low-income group by 1977 standards. In contrast, the performance of the Asian countries is in some cases ambiguous or fairly neutral (Bangladesh, India, the Philippines, and Korea) and in other cases positive (Sri Lanka, Pakistan, Taiwan, and Singapore)--that is, income distribution became more equal with growth. For the low-income countries in this group (India, Pakistan, Sri Lanka, Bangladesh) as well as for Indonesia, the estimated share of the lowest 40 percent is relatively high. Unfortunately, the data for African countries are too scant to provide much information on that region.

While evidence on the relationship between growth and income distribution is somewhat ambiguous, the evidence on growth and poverty alleviation is more clear-cut. For virtually the same sample (with Thailand substituted for El Salvador), Fields finds ten cases where the percentages of the population in poverty decreased, and only three examples where poverty increased--India, Argentina and the Philippines. Since the average growth rates of per capita income were fairly low for both India and Argentina for the periods in question (1.2 percent and 1.4 percent), this hardly constitutes a failure of rapid growth.

In addition, a number of simulation studies that incorporate the assumption that income distribution will follow the path described by the Kuznets Curve also indicate that the incidence of poverty nonetheless declines substantially as per capita GNP increases. [Description of studies omitted from this extract.]

None of this is to deny the importance of the *pattern* of growth in terms of the distribution of increases in income and the composition of changes in output. Equation (2) above indicates that for low-income countries variations in the share of the lowest 40 percent of income recipients (YD) can have powerful effects on the incidence of poverty associated with a given income level. But the key point is that if rapid growth can be achieved in low-income countries, the effects in terms of poverty alleviation are likely to be substantial and positive even with some worsening of the income distribution. And if that worsening can be avoided, as past experience suggests that it can, so much the better.

III. The Distribution of Official Development Assistance Among Recipient Countries

The current distribution of aid flows. Official Development Assistance (ODA) is defined by the Development Assistance Committee (DAC) of the OECD as grants or loans undertaken by the public sector (including international agencies as well as national donors) that have as their main purpose the promotion of economic development and welfare, and that are offered at concessional terms (if a loan, at least 25 percent grant element). This concessional assistance comprises only a portion of total resource flows to developing countries. For instance, in 1976 ODA accounted for about 30 percent of total disbursements of medium- and long-term capital from industrialized to developing countries. (For the World Bank Group, lending by IDA of $2.86 billion in 1978 was counted as ODA, while IBRD lending of $6.55 billion was not.)

The data presented in Table 3 represent average annual commitments of ODA during the 1976-78 period from all sources except cen-

Table 3: THE DISTRIBUTION OF POVERTY AND OFFICIAL DEVELOPMENT ASSISTANCE, 1976-1978

Recipient Country Group: 1977 Per Capita GNP	Percent of Total Poor (%)	ODA Commitments ($ million per year)	Percent of Total ODA (%)
Less than $150	17.4	3,385	13.3
India - $150	37.2	2,100	8.3
$150 - $300	26.1	5,793	22.8
$301 - $450	9.8	4.979	19.6
$451 - $1,200	6.2	5,541	21.8
$1,200 - $4,800	3.2	3,605	14.2
Total	99.2	25,403	100.0

SOURCE: World Development Report 1979, (World Bank) and Development Cooperation 1980 (OECD).

trally planned economies. They include commitments by OECD countries, multilateral institutions, and countries belonging to OPEC. The data have been collected for 102 recipients who received at least $75 million each in ODA commitments over the three-year period. The countries collectively accounted on average for over $25 billion per year, nearly 90 percent of total ODA commitments reported by the DAC.

The data in Table 3 indicate that the low-income group (under $300) which accounts for 80 percent of the developing world's poor receives only 44 percent of concessional assistance, while countries accounting for less than 10 percent of the poor (over $450) receive 36 percent of concessional assistance. India alone accounts for a great deal of this disparity between the distribution of poverty and the distribution of ODA.

Explaining the allocation pattern. A number of studies in recent years have sought to explain allocation patterns of development assistance. Paul Isenman (1975) investigated flows of development assistance during the late 1960s and early 1970s from a variety of sources: USAID, DAC members as a group, the IBRD, IDA and the UN Development Programme. His results strongly confirmed two "biases" in aid allocations: a middle-income bias, revealed in the tendency for per capita assistance to rise as per capita income increases to a level of $400 (in 1970 prices, equivalent to about $650 in 1977 prices), and then to fall; and a country-size bias, reflected in the tendency for per capita assistance to be lower the larger the population of the recipient. Edelman and Chenery (1977) used aggregate data on commitments of "Official Concessional Assistance" (i.e., ODA plus multilateral loan commitments that are not sufficiently concessional to qualify as ODA) from OECD countries, international organizations, and OPEC to a sample of 89 countries. Their tests confirmed both the country-size and middle-income biases (although the middle-income bias for the 1970-72 period was not statistically significant). Dudley and Montmarquette (1976) tested 1970 commitments from various bilateral donors, for recipient population, per capita income, political ties to the donor in question, economic ties to that donor, and "bandwagon" effects (the tendency for a donor to give more aid to countries receiving substantial amounts of aid from other sources). Their results indicated an insignificant role for population size in explaining aid allocations of most donors once political, economic and bandwagon factors were taken into account.

Are the middle-income and country-size biases still reflected in more recent allocations of assistance? To gain some perspective on this question, I tested the following equation for 1976-78 assistance for a sample of 101 developing countries.

The explanatory power of the equation is fairly high (69%). The population coefficient is clearly significant and evidences a very strong bias against large countries. This accounts for much of the

$$\begin{array}{lllll} (3)\ \text{Log PCA} = & 10.38 & - .73\ \text{Log Pop} & - 1.89\ \text{Log PCY} & + .147\ (\text{Log PCY})^2 \\ \text{t-values} & (3.2) & (13.0) & (-1.8) & (1.8) \\ & & & & R^2 = .69 \end{array}$$

PCA = Per Capita Assistance 1976-78.

Pop = Population.

PCY = Per Capita Income in 1977.

concentration of assistance in middle-income countries, which on average have smaller populations than the low-income countries, even when India is excluded from the latter group. The per capita income coefficients indicate a *reversal* of the middle-income bias, i.e., a tendency for per capita assistance to *fall* as per capita income *increases* to about $620 and then to rise; but these trends were not highly significant statistically.

Before concluding that the behavior of donors has changed, several factors need to be mentioned that make it difficult to compare these results with those of Chenery/Edelman and Isenman. The former included "hard" loans from multilateral banks that were not sufficiently concessional to qualify as ODA and which were excluded from my figures; most of these funds go to middle-income countries. Secondly, my sample of countries includes a number of very small, high-income recipients of ODA not included in either of the other two studies. This, too, had an effect on the assistance-income relationships.

While the equations tested omit political variables, it is obvious that these play an important role in the allocation pattern. For instance, the four largest deviations of actual from predicted allocation levels are accounted for by Egypt, Israel, Jordan, and Syria, which together claimed over $6 billion in annual ODA commitments, almost 25 percent of the total.

Mechanisms for changing the allocation pattern. Questions about what factors explain the existing assistance allocations lead naturally to questions about how aid ought to be allocated, and in what directions. Both Isenman and Chenery/Edelman argue that the country-size bias ought to be softened if not eliminated, and that the bias towards middle-income countries ought to be converted to one towards the low-income countries. Several allocation models have been developed, aimed at explicitly addressing these biases.

Cline and Sargen propose an aid allocation model that determines allocations of development assistance according to need and performance criteria (World Development, June 1975). Their approach starts, as most donors would, with a specified amount of assistance and a list of potential recipients. They then seek a linear path such that *per capita assistance* declines as per capita income increases. Thus they incorporate an explicit bias in favor of low-income countries, and remove any bias based on population size. By stipulating a ceiling level of per capita income at which assistance falls to zero, they can determine a unique linear relationship between per capita income and per capita assistance that will use up the exact amount of assistance available.

The next step is to incorporate country "performance" criteria, that are used to adjust in either direction the allocations determined by the need criterion alone--i.e., per capita income; this measure implicitly takes account of population size along with need. The factors that are taken into account in performance include a high savings rate, high export growth, low inflation, high tax revenues, and efficiency in resource use as measured by a low incremental capital/output ratio. Two of these indicators--savings and tax revenues --are measured in terms of deviations from expected performance as predicted by per capita income. Thus, a low-income country's savings performance would be evaluated relative to the savings rate expected of an average low-income country, rather than in comparison to the higher savings performance of middle-income countries. Each indicator is normalized by dividing by the respective standard deviation. For each country the five indicators are aggregated into a single composite performance indicator, using an arbitrary weighting scheme. This indicator is then used to adjust per capita allocations upward for high performance or downward for performance below average. A broadly similar allocation model [described more fully in the original] has been developed at AID and used to arrive at preliminary indicative levels of development assistance for medium-term planning purposes. (The model is developed in Michael Crosswell, "Basic Human Needs and the Distribution of Development Assistance Among Countries: The Indicative Planning Allocation Procedure," AID Mimeo, August 1979.)

IV. Foreign Assistance and Growth

Empirical evidence that aid contributes to growth. The discussion so far has pointed to a concentration of the LDC poverty problem in low-income countries, and a concentration of concessional foreign assistance in middle-income countries. Given a concern with poverty alleviation, the argument for an increase in concessional assistance to low-income countries rests on two propositions: that growth can be effective in alleviating poverty in these countries, and that increased foreign assistance can make a significant contribution to growth. We now turn to this latter proposition.

The main evidence against the argument that increased assistance accelerates growth rests on the finding that foreign capital inflows and domestic savings rates are inversely correlated. Weisskopf estimated that "approximately 23 percent of net foreign capital inflow substitutes for domestic savings" (Journal of International Economics, Vol. 2, No. 1, 1972, p. 37). Other authors have found similar negative correlations.

Papanek provides a review and criticism of this literature that accepts the observed negative correlation between foreign inflows and domestic savings, but sets forth several arguments against a conclusion that foreign assistance causes savings efforts to decline (The Economic Journal, Vol. 82, No. 327, 1972). One argument is that some foreign assistance is explicitly directed towards activities commonly classified as consumption rather than investment--emergency food aid; military assistance; recurrent cost financing of some government services such as health, education and agricultural inputs; and so forth. Yet insofar as it is provided as a grant, it has no bearing on domestic savings effort. A second argument rests on the tendency for assistance to rise in times of crisis caused by exogenous factors such as war, weather, or adverse movements in the terms of trade; in these situations, savings are likely to fall more sharply than income, which would produce an observed negative relationship between foreign assistance and savings rates, again without reflecting causality from increased aid to diminished savings effort. Papanek concludes that "As long as both savings and foreign inflows are substantially affected by third factors, the negative correlation between the two found in many studies sheds little or no light on their causal relationship," (op. cit. p. 950).

Even if a dollar of foreign assistance increases investment by somewhat less than a dollar, the effects on growth can nonetheless be positive and substantial. In a subsequent paper (Journal of Political Economy, Vol. 81, No. 1, 1973), Papanek tests the effects of domestic savings, foreign assistance, private foreign investment, and other foreign flows (short term capital)--all measured as ratios to GDP--on growth of GDP. The samples tested include a group of thirty-one Asian countries, and a larger group of eighty-five developing countries:

		Savings	Aid	Foreign Investment	Other Flows	R^2
Growth =	1.5	+ .20	+ .39	+ .17	+ .19	.37
(n=85)	(2.5)	(6.0)	(5.8)	(2.5)	(2.1)	
Growth =	1.5	+ .21	+ .46	+ .35	+ .13	.46
(n=31)	(1.5)	(5.0)	(4.4)	(1.7)	(0.8)	

(T values in parentheses)

The various sources of investment collectively explain a fairly substantial portion of observed growth performance. Particularly noteworthy are the relatively high coefficients for aid, which appear to have a more significant effect on growth than either domestic savings or other forms of foreign resource flows. However, these may be somewhat exaggerated; the validity of these coefficients for aid depends on whether aid is correlated with other sources of growth not included in the equation. If aid flows disproportionately to countries that make better use of resources, for example, then the coefficients for aid in Papanek's results would be overstated (unless it was aid which caused the higher efficiencies).

The most prevalent analytical framework for relating flows of foreign assistance to growth in GNP is the two-gap model (Chenery and Strout, American Economic Review, Vol. 56, No. 4, 1966). Chenery and Strout used this model to formulate projections of growth and foreign assistance requirements over the 1962-75 period for fifty developing countries. Chenery and Carter provided an interim review of development performance relative to these projections for the period up to 1970. Lewis and Michalopoulos (unpublished AID paper, January 1980) have recently looked at the Chenery/Strout and other projections of developing country performance through 1975. These reviews provide some insights into the contribution of foreign assistance to more rapid growth.

Chenery and Carter (American Economic Review, May 1973) note that growth over the sixties was on the whole fairly close to the projections in their model. Of thirty-seven countries, twenty-five were within 1.2 percentage points of projected rates, five grew substantially more rapidly, and seven grew much more slowly. Overall there was a considerable shortfall in foreign capital inflows; however, export performance was much better than projected. Of five countries where growth was high: the foreign capital inflow was of major significance in explaining the surprisingly good performance in Kenya and Thailand; of less significance in Korea; and unimportant in Iran and Taiwan. For 13 low-growth countries, only four received amounts of assistance even close to their projected needs. Of course, the causality between poor performance and low aid levels can run both ways. Chenery and Carter single out India as an important case where shortfalls in foreign assistance severely constrained growth; they argue that, based on India's savings and export performance, aid allocated to India on a basis comparable to other countries would have raised the annual growth rate from 3.5 to 5.8 percent.

The review by Lewis and Michalopoulos for the 1960-75 period provides an analysis by region that compares the foreign capital inflow in 1975 with the level projected by Chenery and Strout. For South Asia, the projections called for $8.1 billion, whereas the actual foreign capital inflow was $2.6 billion. There was a corresponding shortfall in the growth rate of investment over the period (4.6 percent actual versus 7.9 percent projected) and of output (3.8 percent versus 6.1 percent projected). For sub-Saharan Africa the foreign capital inflow in 1975 exceeded the projections ($5.4 billion versus $3.7 billion) but investment growth fell well short (5.8 percent versus 7.3 percent projected). Nonetheless, the GNP growth rate was close to what was projected (4.4 percent versus 4.8 percent projected). Insofar as large amounts of aid were used in Africa for relief of drought and famine during the first half of the 1970s, this may explain the low savings and investment growth.

The evidence presented by these studies on the importance of foreign assistance in achieving accelerated growth is ambiguous, in part because the experience of various countries and regions was mixed, and in part because there is not a clearly valid methodology for identifying the contribution of increased foreign assistance to accelerated growth, or the lack of foreign assistance to slow growth. For our purposes, the most important point concerns the experience of South Asia in general and India in particular, insofar as both papers suggest that nonavailability of foreign capital severely constrained investment and growth in the region where most of the world's poverty is concentrated. [Discussion of evidence from simulation studies omitted here.]

Outlook for the 1980s. Since the bulk of this paper was written, the World Development Report, 1980 has been issued. Prospects for the low-income oil-importing countries--essentially the low-income countries discussed in this paper other than Indonesia, Angola and Zaire--are seen by the World Bank as quite dim in light of the 1979-80 increases in oil prices. Over the next decade, the average annual growth rate in per capita income for this group is projected to be somewhere between 1.1 and 2.0 percent. Growth at these rates will result in only very slow progress in reducing the high incidence of poverty in the group of countries that account for most of the world's poor, and quite possibly implies an increase in the absolute numbers of poor. The urgency of international measures to accelerate the flow of concessional assistance to low-income countries, as well as domestic policies to ensure that foreign assistance effectively contributes to their growth, has never been greater. In the absence of such measures, discussions of whether growth does or does not result in substantial reductions of poverty will be purely academic.

[Extracted from Chapter 5 of Basic Needs and Development, Danny M. Leipziger, editor, Copyright© 1981 by Oelgeschlager, Gunn and Hain, Publishers, Inc., Cambridge, Mass.]

EDITORIAL COMMENT: SOME TRENDS IN THINKING ABOUT DEVELOPMENT IN THE 1970s AS REFLECTED IN THE DEVELOPMENT DIGEST

Gordon Donald

It is almost exactly a decade ago that Mahbub ul Haq of the World Bank, formerly Chief Economist of the National Planning Commission in Pakistan, spoke up at the 12th World Conference of the Society for International Development in Ottawa, Canada, with a critique of the theory and practice of development planning, of which he was a leading practitioner. He found that prevailing development policies, even successful ones, seemed to do little or nothing for the very poor people in countries like Pakistan, that governments hardly knew what was happening to their poor populations, and that economic theory provided too little guidance to effective remedies for poverty. He proposed "that we stand economic theory on its head and see if we get any better results." To many in the audience (including this editor) his speech seemed eloquent and thought-provoking, and it found its way into the Development Digest (see D.D. October 1971, p. 3).

This shift of attention toward the poor within developing countries has been one of the important themes in the evolution of development thinking in the 1970s, though not the only one. Two other kinds of shift in emphasis should be noted: increased attention to the development of agriculture and rural areas, which had tended to be neglected in favor of industry; and an increase in concern with employment as such, due to growing problems of underemployment. There is a relationship between these trends and the concern with poverty: the majority of the poorer people in most developing countries are working in agriculture, and in rural areas generally; and the poor are also the underemployed, urban or rural.

A focus on employment creation (see D.D. October 1969, pp. 3-48; January 1971, pp. 77-124; January 1972, pp. 87-124) leads into the technologies used in either agriculture or industry: if the most "modern" methods of production are capital-intensive they will use up limited supplies of capital faster, and create fewer jobs, than would use of a labor-intensive method. If wages are low enough the latter may also be the lowest in cost; but this does not necessarily follow, as there are other dimensions to the problems of efficiency (explored in D.D. October 1976, pp. 69-124). The use of "intermediate technology" does not take care of all such efficiency problems; each case must be considered individually. At the same time there is a gener-

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alized situation referred to as "dualism": high technology (eating up capital) and high incomes in a small modern sector, contrasting with a (capital-starved) traditional sector of low-productivity low-income activities in the rest of the economy. Much of the effort to deal with underemployment consists in combating trends that seem to cause this dualistic condition to persevere and intensify. Many of the proposed counter-measures remain somewhat controversial, however, since they upset political and economic interests in existing industries, and since higher labor intensity can be portrayed as "backward."

Along with the critique of capital-intensive technology there has been a growing interest in the development of rural areas. With agriculture as the central activity rural growth requires increasing farm production, which implies improved crops and methods obtained by increasing extension services, credit, marketing, etc. But here too, as in the cities, there is a problem of dualism: conventional extension, credit and marketing institutions seem better adapted to larger farmers than to small ones. Accordingly, small farmer problems have been getting increased attention (D.D. January 1974, pp. 47-64; October 1974, pp. 55-80; July 1978, pp. 3-50). Also involved in the new rural emphasis are non-farm activities like rural industries, public services and public works (e.g., D.D. October 1973, pp. 41-80). Beyond that, the landless rural poor, usually the most disadvantaged and neglected element, are becoming of interest to some groups (D.D. January 1979, pp. 3-26). Aid donors have devoted increasing sums of money to integrated rural development programs, including innovative pilot projects along with conventional agricultural projects. Some of the newer approaches have encountered problems different from those in conventional projects, and the attempt to develop theory on how best to mobilize rural people and resources has been pursued (D.D. July 1975, pp. 3-46). At least one economist has outlined a sophisticated rural-led development strategy (John Mellor in D.D. January 1977, pp. 3-31) as against the more usual industry-led approach.

At a more general level, there has also been a questioning of the basic purposes of development, and of the ways in which developmental progress is measured. The conventional ideas on purposes of development have been assumed to center around national economic growth--growth in the production of all kinds of goods and services, conventionally measured by GNP (gross national product) per person in a national population. But the per capita GNP measure has come under attack, not only as being a lot less precise than it pretends, but as unsuitable because it does not focus on progress for the poor (see D.D. January 1973, pp. 75-90 for two sides of this question). Alternative measures of developmental progress have been proposed (D.D. January 1980, pp. 75-124). The most widely espoused of the poverty-oriented alternatives has been that of meeting the "basic needs" of a people (D.D. January 1977, p. 32, and January 1978, p. 119; on policy implications see also D.D. July 1979, p. 55). Progress could be measured not by overall economic growth regardless of who benefited and how much, but rather by the extent to which the basic needs of an entire population for adequate food, shelter and clothing were being met. The list of such basics is usually extended to health care facilities and primary education, and sometimes the concept of "participation" in decision-making or some related idea is included.

In some quarters the questioning of economic growth as a goal was carried to a more radical attack on growth as such, based on a concern for what it was doing to the world's environment--that is, its allegedly destroying the physical base on which we all depend. The "limits to growth" were heatedly debated in the early 1970s (see D.D. October 1974, pp. 3-52 for pros and cons). The major thrust of the environmental movement, however, has not been in an anti-growth direction so much as in efforts to modify developmental activities in order to preserve or enhance the environment and therefore the growth potential of the future (D.D. January 1971, pp. 3-42; April 1972, pp. 3-42; January 1975, pp. 107-124). For the most part, intellectuals in the developing countries have resisted the extremes of the limits-to-growth proponents, feeling that their own countries had not yet had their growth opportunities--a consideration that may have made some people unduly wary of the environmentalists' arguments in more limited spheres.

Even if the notion of clear-cut growth limitation is rejected, the emphasis on combating poverty does in some degree restrain the enthusiasm for growth if it is thought that there is a necessary trade-off, or choice, between them--that is, if a focus on improvement among the lowest income receivers can only be achieved at the cost of at least some slow-down in national economic growth rates. In the later 1970s attention turned toward a search for ways to obtain greater "equity," a greater equality in national income distribution (D.D. July 1978, pp. 95-124, and October 1978, pp. 99-124; on political aspects of the tolerance of inequality, see D.D. April 1974, p. 55). As the results of particular policies were examined, however, it became apparent that it is difficult to bend societies very rapidly toward greater income equality. Policies to spread employment more widely in industries, to raise rural incomes via rural investments and (as pertinent) land reforms, and others have tended to work out more slowly than many had expected. But in Cuba, where extreme revolutionary methods of equalization had been followed, the weakness of the growth record despite much foreign aid has pointed to a significant growth-equity trade-off.

Some of the thinking on trends in income inequality has suggested a kind of inevitability in the development process: it was thought that low-income countries would first have to go through a process in which the poor would be left behind other groups in society while the economy created new enclaves of superior wealth and technology; at a later stage of growth, the developmental benefits would begin to spread more widely after a period of learning and consolidation. Indeed, this kind of process is discernible in the history of earlier stages of development in Western Europe, and analogous processes are discernible in Eastern Europe and the U.S.S.R. as well. Such a process has been inferred for the presently poor countries by reference to the "Kuznets curve", on which the greatest inequalities are found among the countries at a middle income level.

This brings us to the preceding article by Michael Crosswell, in which the author argues that more recent data collection has failed to support the inevitability thesis. Low-income countries have not moved consistently toward greater inequality in income as they advanced up the development ladder with increasing per capita GNP: some did follow this path, but equal or greater numbers did not. In any case, too little is yet known about these shifts in the majority of developing countries to assert the inevitability of the path leading through greater inequality. And, clearly, there are countries which have made a success of growth and equity together--which does not mean that every nation could do the same, but it indicates that the possibilities are not predetermined and foreclosed. Crosswell's article implies a faith in economic growth in low-income countries as the basic element in any war on global poverty--not the only element, of course, but one that we cannot do without.

Have we returned to the point where we were before these debates of the 1970s began? Such a conclusion does not follow, since much has been learned from experience in the interim about how more rapid and sustainable growth can be achieved, about how a variety of variables affect different income groups, as well as about other aspects of development such as technological choices, environmental impacts, and others. We cannot but be wiser today, even if much remains to be learned or investigated more fully. There remain differences in values, in what different people may want for their country's future. Some may want faster progress toward modernity as they interpret it, which may include military and political power; others may lay stress on meeting basic needs; some prefer centralism, others decentralized methods of governing. Technical experts and economists cannot tell people what they should want, but they can indicate some of the results of following various possible policies.

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CONTENTS

Volume XIX, Number 4 October 1981

PLANT GROWTH FRONTIERS

PLANT GROWTH FRONTIERS 3
Gordon Donald and Michael Whiteman

NEW ROADS TO NITROGEN FIXATION 4
Marcus Franda

BETTER WAYS TO FIX NITROGEN 12
Kenneth A. Kovaly

NEW CHEMICALS PROMISE LARGER CROPS 16
Thomas H. Maugh II

POPULATION TRENDS

POPULATION TRENDS AND PROSPECTS 23
W. Parker Mauldin

MEN AND FAMILY PLANNING 35
Bruce Stokes

PROSPECTS FOR IMPROVED CONTRACEPTION 43
Linda Atkinson, S. Bruce Shearer,
Oscar Harkavy, and Richard Lincoln

SIGNS OF CHANGE IN MORTALITY TRENDS--
IS PROGRESS SLOWING? 54
Davidson R. Gwatkin

CLEAN WATER

WHY A WATER AND SANITATION DECADE? 67
Earthscan

SUPPLYING WATER: MAINTENANCE PROBLEMS
AND COMMUNITY PARTICIPATION 74
Anil Agarwal

SANITATION AND WELL BUILDING 86
S. B. Watt and W. E. Wood

AFRICAN DEVELOPMENT

PERSPECTIVES AND PROBLEMS OF DEVELOPMENT IN SUB-SAHARAN AFRICA 95
Shankar N. Acharya

FOOD PROBLEMS AND PROSPECTS IN SUB-SAHARAN AFRICA 118
U.S. Department of Agriculture

INDEX 133

Money values will be expressed in U.S. dollars unless otherwise specified. The spelling "tonne" will be used to indicate metric tonnes (1000 kilograms), and "ton" will refer to traditional U.K.-U.S. tons (2000 lbs. or 2400 lbs.).

PLANT GROWTH FRONTIERS

LIBERIAN FARMER FERTILIZING RICE ON THE GBEDIN RICE PROJECT, LIBERIA (Photo: FAO, G. Tortoli).

Plant Growth Frontiers

Gordon Donald and Michael Whiteman
Editors of the Development Digest

The following three articles deal with newly developing methods of increasing plant growth. The importance of achieving gains in agricultural crop yields for overall development in Asia--where population presses on land supplies, in Africa--where traditional methods of cultivation can no longer feed the people, and in Latin America--where growing populations and receding settlement frontiers are evident in most areas, cannot be overestimated. Especially in countries which have limited industrial exports, agricultural productivity is a key to overall economic growth as well as to nutritional welfare. Nitrogen plays an essential role in improving agricultural productivity.

Today nitrogen is added to the soil most commonly by applying chemical fertilizers (phosphate and potash fertilizers are not covered here). But the rising cost of natural gas, which has been a necessary input for the present method of manufacturing nitrogen fertilizer, has been seriously raising the price of such fertilizer since 1974. Gas is a non-renewable source and its consumption cannot be expanded indefinitely, while the demand for soil fertility increase is one that looks to be expanding for years to come. So the need to seek other ways of making nitrogen fertilizer that will not depend on fossil fuels is clear. The first two articles consider some alternatives in the manufacturing process.

Nitrogen from the air is "fixed", i.e., changed into a form which can contribute to plant growth and production, in the chemical fertilizer factories. But the fixation process also occurs in nature; biological nitrogen fixation has always been the largest contributor of fertility to the soil, compensating for the removal of nitrogen from it by the growth of trees and plants. This process is beginning to be better understood for purposes of human exploitation. The kind of biological fixation which is best studied is that performed by a genus of microbe called *Rhizobium* which form nodules on the roots of certain legumes (beans, clovers, and others). The activity of these microbes is the basis of much of the soil fertility renewal from crop rotation. This subject was discussed in the *Development Digest* of October 1975, p. 18, and the ways in which this process can be, and in some areas has been, used for farming were described. The two articles that follow here pursue the subject further. They tell of some of the new avenues that scientists are following to increase biological nitrogen fixation by exploring different microbes and different plant hosts, and by using some of the biological creation possibilities emerging from recent research results with recombinant DNA--that is, altering the sequence of the elements in the genetic code of different microbes or plants to obtain new qualities.

The final article takes a different direction in reporting some very recent discoveries of the capabilities of two newly developed chemicals, both of which appear to contribute substantially to plant growth and which may become obtainable at reasonable cost. All of the possibilities discussed here are on the scientific frontier in one way or another, although some are closer than others to reliable applications at reasonable cost.

New Roads to Nitrogen Fixation

Marcus Franda

[This article describes three projects under way in a leading laboratory specializing in nitrogen fertilization: (1) avoiding fossil fuels in the manufacturing process; (2) use of the azolla fern in conjunction with rice growing; (3) developing new nitrogen-fixing microbes.]

Founded in 1930 for the study of chlorophyll and photosynthesis by the inventor Charles Kettering, the Kettering Foundation Laboratory in Yellow Springs, Ohio has attained a leadership position in basic research in this field. In the 1970s it shifted focus somewhat toward specializing in the area of nitrogen fixation.

Current Projects

Nitrogen fertilizer generator. One of the most talked about short-term projects at the Kettering lab is the development of a small nitrogen fertilizer generator, using an old electric arc discharge method that was discovered at the beginning of this century. Essentially, the process requires that air be pumped through an electric arc in such a way that the nitrogen and oxygen in the air combine to make nitric oxides. Through a system of rapid quenching of temperatures, the nitric oxides are made to react rapidly with oxygen in the air to form gases, which are in turn pumped through water to form nitric acids. These acids can then be neutralized by running them over limestone or calcium phosphate, the end product being a form of liquid fertilizer that can be fed directly into irrigation water, sprayed on fields, or stored indefinitely.

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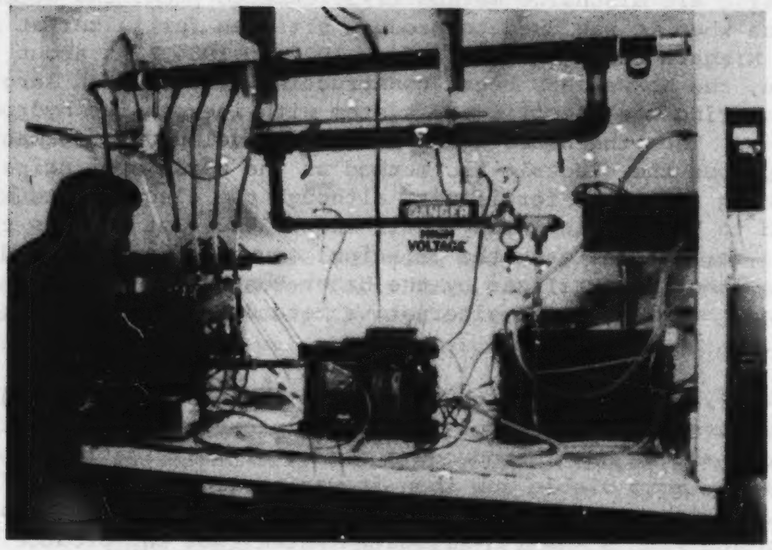
New Hampshire.

Although there is evidence of its use as early as the 1880s, the electric arc discharge method first came to prominent attention in America when it was used to produce nitrogen fertilizer at a plant in Niagara Falls, New York from 1902 to 1904. At about the same time, the Norwegians began constructing several much larger plants powering the electric arc system with inexpensive hydroelectric power. Then the Haber-Bosch process, developed in Germany in 1913, replaced the electric arc method as the world's principal means of producing synthetic fertilizer, although the electric arc method continued to be used in Norway until the 1930s. But today's spiraling costs for natural gas--the principal source of energy used to produce synthetic fertilizer by the Haber-Bosch process--have recently led to a search for alternative methods of producing fixed nitrogen.

R. William Treharne of the Kettering lab has been the major figure involved in the attempt to revive interest in the electric arc method, and he has introduced a number of modifications that might make it more viable now than it was earlier. Instead of large-scale plants like those in Niagara Falls or Norway, Treharne has been experimenting with a small 3-kilowatt system that can produce a ton of fixed nitrogen per 50,000 kilowatt hours. Treharne is hoping to develop a small and simple but efficient system that would enable farmers in isolated areas to produce fertilizer on their own farms with solar, wind, or hydroelectric power, from small, individually owned generators.

A prototype of Treharne's fertilizer generator has been installed on an experimental farm at the University of Nebraska, being powered by a costly photovoltaic solar array longer than a football field. That installation has been producing fertilizer during long intervals of time when the solar array is not being used for irrigation purposes but at the outrageously high cost of $28 per peak watt. Treharne is convinced that solar power is the most expensive way to run the electric system; solar costs would have to come down from their present average of $7-$10 per peak watt to around 50 cents per peak watt to make his system economical.

More promising than solar energy is the possibility of driving the fertilizer generator by wind power. Treharne hopes to work with people from the University of Hawaii to install a wind-driven prototype on the Big Island in either late 1980 or 1981. A third prototype, powered by hydroelectric energy, is scheduled to be installed in Nevada in early 1980. A private contractor has already developed a 3-kilowatt turbine that can be powered by water traveling down from a 400-foot elevation through a pipe 2 inches in diameter.



A prototype of the electric arc
fertilizer generator.

The Kettering lab has received a number of inquiries about and requests for prototypes of the arc generator, with most of them coming from Latin America, India, and Nepal. But the Kettering Foundation is determined that it will not release the system for worldwide distribution until it has carried out more experimentation because, as Kettering Trustee Harrison Brown said, "The Third World is littered with great inventions that failed because they were introduced too fast." The appeal of the arc generator to policy-makers in the less-developed countries is understandable. If it works, it could provide a source of nitrogen fertilizer to farmers in the most remote areas, using only water, the wind, or the sun for energy. The only components of a fertilizer unit would be an electric generator, water, a neutralizing agent like limestone, a few tubes and wires, a pump, and the know-how to keep the system functioning. Treharne has developed an enclosed unit that could conceivably be installed, maintained, and replicated in regions where some basic skills do exist in the countryside (in Punjab or Nepal, for example). Particularly in remote areas where electricity and fertilizer are not available but there is an abundance of hydropower, the electric arc generator could be of great importance in the future.

Kettering is carrying out a number of tests of the endurance and wear on some of the components of their basic three-kilowatt system--especially the electrode, the air pump and several small electrical motors. They are also trying to find ways to use some of the waste heat that now constitutes the major inefficiency of the arc process. Finally, they are trying to find more efficient ways to collect the nitrogen acids and convert them to calcium nitrate and phosphoric acid, the ultimate goal being to produce a ton of fixed nitrogen in the form of usable fertilizer per 25,000 kilowatt hours of electricity, as compared with a ton for every 50,000 kilowatt hours at present.

At this point in the development of the electric arc process, it would appear to be of greatest potential benefit in Asia to the wealthier farmers. The cheapest system that Treharne has developed thus far is a laboratory model, a 3-kilowatt enclosed hydro unit that costs $4,000 for the hydro generator and $900 for the arc generator. Treharne estimates that such a unit could produce enough fertilizer for 20-25 acres of land at present rates of application on South Asia's most progressive farms. This might make the unit quite attractive to those farmers who now own that much land, but 20-25 acres in Asia is a large holding. Experiments with cooperative use by smaller farmers of new inventions have not been very successful. Even if a poor farmer in Asia could find a way to acquire one of Treharne's 3-kilowatt units, the system takes up at least a small room and requires for efficient operation some minimal understanding of mechanics and electricity. [Comment: Village-sized projects need not be ruled out for all of the Third World.]

The Azolla fern. The Kettering project that is most likely to provide benefits to poorer farmers in South Asia in the short run is experimentation with the small fresh-water fern Azolla, being conducted by Gerald Peters and his associates. A single Azolla plant grows no more than one-quarter inch high at full maturity, but some species of the tiny ferns layer themselves on top of one another to reach a possible combined height of an inch or two. Nitrogen is fixed by a blue-green algae that is always found inside cavities of the Azolla fronds. Wherever you have Azolla, you have an assured source of nitrogen fertilizer. There are also a number of free-living blue-green algae, but such algae are not as good at fixing nitrogen in their free-living state as those found inside the Azolla fern. The Chinese have known about Azolla for hundreds of years and have cultivated it in tanks and greenhouses over the winter months, for use on paddy fields in the spring. Depending on species, the plant grows in almost any wet place and in a wide range of climates. In most countries--America included--it is considered a weed.

Peters has obtained and identified four of the five, possibly six known species of Azolla. He is attempting to understand how the plant functions, how to optimize its biomass production, and how to increase the efficiency of the blue-green algae in fixing nitrogen. Other scientists in Belgium, the Netherlands, England, China, the Philippines, and India are also doing basic research and field studies with Azolla in the attempt to make it even more viable as a fertilizer crop plant. Extensive field trials are being conducted at the University of California's Davis campus and at the International Rice Research Institute (IRRI) in the Philippines.

Centuries of experience in China, Vietnam, and Nepal have demonstrated that increases in rice yield can be achieved by simply growing Azolla as a green manure during the fallow season. Azolla has the advantage that it adds carbon, other minerals, and nutrients to the soil--thus acting as a source of humus and a soil conditioner--an advantage that is not present with chemical fertilizers. Unlike many other plants, Azolla also breaks down very quickly, which means that the nitrogen is almost immediately available as a biological fertilizer once the Azolla is plowed under or killed. The greatest gains in rice production using Azolla have come in field trials in Davis and at IRRI in the Philippines, where the fern has been systematically grown in various combinations on the surface of the water between rows of rice plants, buried beneath the soil and re-sown at several points during the growing season, and occasionally used as green manure during the fallow season as well. Under these circumstances, Azolla has been found to prohibit weed growth in the rice field, provide significant amounts of nitrogen and other nutrients to the soil, and increase crop yields considerably when compared to an unfertilized control plot.

The importance of Azolla is that it can provide a bountiful source of nitrogen biofertilizer to any cultivator who has wet land, without his having to purchase and transport fertilizer. Since the plant multiplies, weed-like, very rapidly, it can already be of great value to any rice farmer who has access to a few parent plants. Throughout the world, Azolla plants are readily available, free of charge. Indeed, much of the scum-like green material commonly seen on stagnant water ponds throughout Asia is Azolla, or free-living blue-green algae. Should farmers ever be able to adopt some of the more sophisticated Azolla and rice crop rotations and interplantings being tried at Davis and in the Philippines, increases in rice production could conceivably equal those for fields where chemical fertilizers have been used.

Peters' work is significant because he could: (a) identify the best species and varieties of Azolla for a given environment; (b) help work out management techniques; and (c) eventually breed new varieties. Peters discovered in 1974 that it is the blue-green algae, and not the fern, that actually fixes nitrogen. He has since found that the algae does not keep growing forever but instead goes into what he calls a "metabolic idling" and quits dividing once it has filled the cavity of the Azolla fern. In his attempts to maximize the nitrogen-fixing potential of the symbiosis, Peters is now trying to find out more about the functioning of the enzyme within the blue-green algae and the interaction between the algae and the fern. He also talks about the possibility of creating more ideal plants by hybridization, and of discoveries that might make it possible to desiccate Azolla spores. The ability to desiccate spores would gain for man the capability of multiplying them at incredibly rapid rates and storing them with unprecedented ease.

A pond of the Azolla fern growing in Mainland China (Photo credit: Gerald Peters).

Finally, Peters would like to find a herbicide that would selectively kill Azolla without affecting rice plants. If this could be done, the Azolla could be selectively killed several times during a growing season without having to use large amounts of manual labor. The difficulties involved in using manual labor to kill and re-sow Azolla are, first, that it is expensive for this purpose, even in low-wage Asia, and second, its use results in damage to the roots of rice plants. The more often Azolla plants can be brought to full cover and killed during a growing season, the more nitrogen is fixed in the soil. If an inexpensive Azolla herbicide could be developed that would not disturb the roots of rice plants, its impact on the lives of poor rice farmers throughout the world would be widespread.

Other nitrogen-fixing microbes. A third Kettering project that would appear to have important pay-offs in the not-too-distant future is the experimentation being carried out by Maurice Lalonde and his associates with alder and other nonleguminous nitrogen-fixing plants. Less than two years ago, at Harvard University, a group of scientists were able to isolate an unusual fungus-like microbe, now given the species name *Frankia*, which had been known for years as a nitrogen-fixing microorganism that would infect a group of specific non-legumes, in the way that *Rhizobia* infect legumes. The discovery at Harvard has made it possible to grow *Frankia* in culture, out of the nodules of plants, and, therefore, to simplify laboratory experiments. Lalonde's experimentation is designed to reveal more about the functioning of *Frankia* and the symbiosis between them and the plants with which they associate.

Lalonde is particularly concerned with growing trees. His lab is filled with young alder trees and other nonlegumes no more than a few inches high, growing in plastic bags and in growth chambers that look like refrigerators, all the while being examined down to their smallest particle by the most sophisticated electronic machines and microscopes. Alder is particularly important because its 23 species grow all over the world, in climates ranging from the tropics to the coldest parts of Canada, and it has an enormous number of possible uses. In the Soviet Union, the leaves of some species of alder are used as cattle feed--in fact, Soviet cattle prefer the leaves of alder bushes to other foods. Other species are especially fast-growing trees that are of great potential for biomass production. Still others can be reduced to sugars and then used as food or fuel.

Some of the microbes that Lalonde has isolated with his new culture techniques were used to inoculate 86,000 plants across Canada. Others will be tried on large plantings in Senegal in 1980. Lalonde is enthusiastic about the possible applications of his research in the future. The nonleguminous trees that can be "turned on" by *Frankia* include casuarina, coriaria (a New Zealand type of pine), Russian olive, and a host of others. In South America, nitrogen-fixing trees have been planted next to fields of corn, both to provide windbreaks and to furnish nitrogen to the soil. In this case, nitrogen is fixed in the leaves, which can be stored and composted to provide a most valuable source of nitrogen fertilizer.

Selection of the best trees or other plants for any given situation is being studied at various experiment stations. Lalonde's concern, however, is not so much with the plants themselves as with 200 different strains of microbes that can "turn them on." Lalonde has found that some microbes infect a tree more quickly than others, and that "some strains are sloppy--they do not want to do their job well." Others, he says, "just sit there and do nothing at all." Lalonde and his associates are trying to find out which strains work best with which plants, so that field experimenters can be certain that if they develop an excellent nitrogen-fixing tree they will have an efficient microbe to use in association with it. Lalonde is especially anxious to find the right microbe for *Alnus glutinosa*, a tree that grows from Russia to Spain and produces a lot of wood fiber and wood very quickly. Field experimenters at Iowa State are exploring the possibility of introducing *Alnus glutinosa* into the United States on a large scale.

Lalonde has also been corresponding with scientists in India, who have become interested in using the casuarina tree in large-scale plantings. At present, the most widely used tree for large-scale plantings in India is the fast-growing eucalyptus, which does not fix nitrogen in the soil but instead removes it. As Lalonde points out, the casuarina grows all over India and will enrich the soil because of its nitrogen-fixing properties. He is convinced that it will grow as fast as eucalyptus if the right types are selected and the right microbes are used in association with them. The plantings that Lalonde is recommending for Senegal are what he calls "mixed culture," consisting of rows of casuarina interspersed with rows of eucalyptus and other trees. Such mixed cultures make it possible to provide to the soil different nutrients from different trees and also tend to produce plants that are more disease-resistant than those grown in monocultural situations.

In the long run, Lalonde is hopeful that he and other scientists might find ways to sporulate the microbes that infect nonleguminous nitrogen-fixing plants, so they could be more easily stored over long periods of time. He would also like to explore possibilities for translocating nitrogen from one plant to another through "bridges" of microbes in the soil, in such a manner that nitrogen could be transferred from the roots of nitrogen-fixing plants to the roots of non-nitrogen fixers. To accomplish this, he would have to find precisely the right microbe to infect precisely the right combination of plants, a most difficult task when one considers the millions of microbes and plants in the world.

[Extracted from Kettering's Nitrogen Fixers Part III, pp. 5-9. Report No. 15, General. Copyright© 1980, American Universities Field Staff, Hanover, New Hampshire.]

Better Ways to Fix Nitrogen

Kenneth A. Kovaly

[This article begins by describing the principal method used to make chemical nitrogen fertilizer. It then tells of some new alternative ways to reach the same result that are being explored: one is to create new types of bacteria by genetic engineering; another is to eliminate the need for gas or oil in the usual manufacturing process by using new chemicals; a more distant idea is to introduce nitrogen-fixing capability into common food plants.]

The Haber-Bosch process used in the hundreds of plants that make up the worldwide ammonia industry got its start in Germany in 1913. The inventors gave the government just what it needed for World War I--freedom from imported nitrates for explosives. Today this process is the basis for the giant nitrogen-fixation industry, which currently "fixes" gaseous nitrogen from the air into about 80 million metric tons of ammonia per year. Three-fourths of the ammonia goes into nitrogen fertilizers to help grow crops to feed the world. The rest goes into plastics, nylon fibers, animal feed materials, a host of industrial chemicals, as well as civilian and military explosives.

The Haber-Bosch process has been improved and adapted to new raw materials and energy sources. Its plants have been engineered and automated to a high degree of efficiency and are now built on an enormous scale. But the process remains basically the same one the two Nobel prize winners invented on the eve of World War I. Only now is competition for improvement in this venerable process on the way. Gradually--or perhaps suddenly--the huge existing ammonia industry could become obsolete.

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Haber-Bosch ammonia plants get their nitrogen--which makes up 82% of ammonia--from the air. It is free. It is the only item that is. Natural gas or petroleum naphtha are usually used for the high temperatures and pressures (sometimes 1,000 atmospheres) needed to make nitrogen and hydrogen combine in the presence of a catalyst to make ammonia. These hydrocarbon feedstocks--reacting with steam--are also the source of hydrogen.

Coal has been used in the past and will be again, but coal-based plants require much higher capital investments and have not been economic for many years in most locations. Burgeoning fuel costs have run production costs for ammonia up tremendously since 1974, as has the price of new plants. The high pressures and temperatures needed demand a great deal of expensive, specialized heavy equipment. The price tag on a 1,000-ton-per-day ammonia plant--and few companies think anything smaller is economical--is over $75 million.

Bacterial Factories

Long before rising costs of fuel and equipment hit the ammonia industry, chemists had known that there is a better way to fix nitrogen--quietly, at atmospheric pressures and normal temperatures. Certain microorganisms do this. They live free in the soil or in nodules on the roots of legume plants like clover, soybeans, alfalfa, or peas. Before man built the synthetic nitrogen-fixation industry this biological process was the chief source of the fixed nitrogen needed for plant life, and hence animal life. Fixed nitrogen in the form of ammonia or other nitrogen compounds is needed to make amino acids, which make up proteins, the basic building material of all living cells. Attempts to unravel the natural process have been made for many years. Only recently have biochemists come close to understanding the process.

Biochemists now have learned that the natural nitrogen-fixing process uses an enzyme, nitrogenase, to catalyze the reaction between nitrogen from the air and hydrogen from water to form ammonia within bacterial cells. The structure of the nitrogenase is a protein of high molecular weight. A cofactor, an additional molecule, is required for the catalytic activity of nitrogenase. Its structure has not been worked out completely, but it does contain molybdenum, iron, and sulfur. The active site of the catalytic reaction is probably at the portion of the molecule containing these elements. At this site nitrogen and hydrogen atoms are positioned in such a way that the energy needed for the combination is supplied to them and they can react. The source of the energy is the oxidation of carbohydrates by bacteria. The carbohydrates are produced by photosynthesis in green plants.

Genetic Engineering

At present the only practical way to make use of the natural biological nitrogen-fixation process is one that has been used since ancient times--rotating legume crops with other crops to enrich the soil. However, recent discoveries make it possible to do more than this in the laboratory. Nitrogen from air bubbled through a liquid medium in which bacteria are growing can be fixed so that the bacteria grow with no other source of nitrogen. Nitrogenase enzyme can also be extracted from living bacteria and made to fix nitrogen in laboratory glassware. These processes are too slow to be commercial yet, although improvements are coming rapidly. Use of recombinant DNA and other techniques of "genetic engineering" have already made it possible to transfer the capability to fix nitrogen from slow-growing bacteria to common bacteria that grow rapidly under artificial conditions. The same techniques have also made it possible for bacteria to convert nitrogen into ammonia that can be collected, rather than into amino acids.

Further development of these techniques could turn the present nitrogen-fixation industry upside down. One possibility is the development of factories similar to fermentation facilities. In these factories bacteria would grow in large tanks and receive their nitrogen from air bubbled through the liquid culture medium. The by-products of paper mills or other wastes could be used as carbohydrate energy sources for large industrial installations. Bacterial mass could be removed as a sludge that would serve as a rich organic fertilizer. Instead of industrial installations, small units could be set up on individual farms and use crop residues or animal manure as nutrients for bacteria.

Nitrogen-fixing microorganisms might also be grown in tanks to produce ammonia instead of an organic fertilizer. Or nitrogenase could be extracted and produce ammonia directly.

Genetic engineering may also be able to produce nitrogen-fixing microorganisms that will fix nitrogen in the soil much more efficiently than wild strains. These bacteria could be introduced into the soil so that the nitrogen needed by crop plants is produced where it is needed. Other strains might be produced that would grow cooperatively with crops such as corn in much the same way that natural nitrogen-fixing bacteria now grow in root nodules of legumes.

Synthesizing Nitrogenase

Understanding the nitrogenase structure has given some good leads to synthetic organic chemists who have been faced with heavy going in their search for catalysts which would fix nitrogen at normal temperatures and pressures. Compounds have been synthesized which contain molybdenum, iron, and sulfur and may be similar to the active site in the nitrogenase enzyme. So far yields are very low. But if the chemists are on the right track, an industrial process requiring less capital investment and less energy could become a reality. Even more exciting is recent work on entirely unrelated catalysts able to synthesize minute amounts of ammonia from air and water in the presence of sunlight--the sole source of energy.

Commercialization of any of these new ammonia processes could lead to an entirely new structure for the fixed-nitrogen industry. Eliminating the need for natural gas or petroleum fractions could mean that many present locations for ammonia plants--such as those on the U.S. Gulf Coast--would lose their advantages. It is likely that a new process could operate economically on a smaller scale than the existing process. A larger number of smaller plants closer to markets would result, and cause a big shift in the present distribution system. Farm-based units would eliminate the distribution system entirely. A solar process would also mean a big change in the geographical locations of ammonia plants.

The breakthrough that would have the most drastic effect of all may be further away, but is the goal of a number of top-notch research groups that are now working on it. This is the application of genetic engineering to transfer nitrogen-fixation capability from bacteria directly to crop plants. Corn or other crops could then fix their own nitrogen, eliminating the need for nitrogen fertilizers altogether. This would wipe out three-fourths of the existing ammonia industry.

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New Chemicals Promise Larger Crops

Thomas H. Maugh II

[This article describes work on two new chemicals, very recently developed, that promise to be of value for stimulating plant growth. They have not yet been widely tested nor officially approved for sale, however.]

A new generation of plant growth regulators may soon exercise a strong influence on agricultural practices. Unlike earlier generations, which have already proved valuable for such diverse uses as inducing root growth, thinning fruit on trees, regulating crop maturation, aiding harvesting, and increasing the hardiness of plants, the new agents show promise of increasing crop yields and biomass for vegetables, cereal grains, and other produce. The prototypes of this new generation are brassinolide and triacontanol, both of which produce significant increases in crop yields. In recent months, scientists at the U.S. Department of Agriculture (USDA) have synthesized and tested two analogs of brassinolide that are inexpensive enough to use commercially, and that appear to be equally effective. Another scientist, meanwhile, seems to have discovered why results with triacontanol have often been inconsistent.

Brassinolide was discovered in a screening program for new plant hormones initiated at USDA's Beltsville Agricultural Center more than 10 years ago by John W. Mitchell. Mitchell, since retired, began screening pollens because he thought they would have a high concentration of hormones. The USDA group screened

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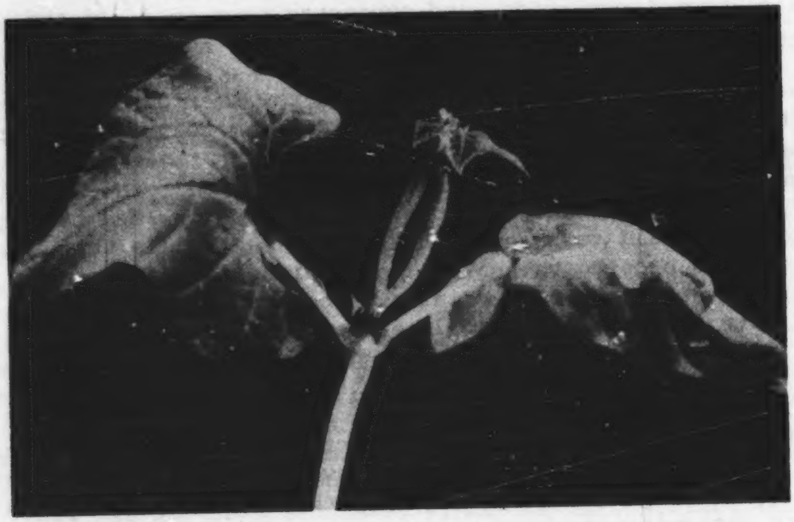
pollen from nearly 60 species and found that about half caused increased growth in bean seedlings. The greatest growth increases were obtained with pollen from alder trees and from rape (*Brassica napus* L.), a forage crop whose seeds yield an oil used as a lubricant and as a food. These two pollens shared an unusual characteristic. When an extract of the pollens was applied at high concentrations, the stem of the seedlings would split above the second pair of leaves because of the rapid growth, and then grow back together. No other compound has been found that produces this effect. The initial results also showed that the active substance was present in the pollen at a concentration of only parts per billion; most hormones are found at parts-per-million concentrations in plants.



Split internodes

If too high a concentration of brassinolide is applied, the stem of a seedling splits above the second pair of leaves, then grow back together. [Source: N. B. Mandava]

Because this discovery was so promising, a Beltsville team headed by N. Bhushan Mandava undertook a crash program to isolate the active substance from rape pollen, which was more readily available than alder pollen. Michael Kozempel and his colleagues constructed a pilot plant for extracting large amounts of rape pollen with 2-propanol. From 225 kilograms of pollen, the USDA team obtained barely 10 milligrams of a pure, crystalline material that they named brassinolide.

On the basis of spectrometric studies in several laboratories, the group reported in 1979 that brassinolide is a steroid. It is the first plant growth regulator that has been found to have a steroidal structure. (Steroid is a molecular classification that includes sex and gland hormones, among other substances.) Application of pure brassinolide to bean seedlings produced significant increases in plant growth at concentrations of only 1 nonogram (10^{-9} or one billionth of a gram) per plant and caused splitting of the stem at concentrations of 10 nanograms per plant.

Because isolation or synthesis of brassinolide itself was obviously too expensive for any widespread use on crops, Mandava and Malcolm J. Thompson of Beltsville synthesized several analogs of the chemical to determine which parts of the molecule are most important for activity. Last year, Mandava and Thompson synthesized two analogs--called brassinosteroids--and subjected them to field and hothouse trials.

Mandava reported at a 1981 meeting of the American Chemical Society that the synthetic brassinosteroids promote growth in the same manner as brassinolide, but that four to ten times as much of the synthetic compounds must be used. Even so, the total amount is still very small--only nanograms per plant. When applied to very young plants in field tests conducted by the Beltsville team, the brassinosteroids boosted the harvest of radishes and lettuce by 15 and 30 percent, respectively. Yields of bean and pepper plants in the field were increased by 6 to 7 percent, and that of potatoes in a small trial by about 25 percent. In greenhouse studies, treated bean and pepper plants weighed 35 percent more than untreated plants and produced a bean crop weighing 32 percent more than untreated plants. Field tests are now being conducted on potatoes in Colorado, and tests are planned for this year at several locations on vegetables, soybeans, and other major crops. Among other things, these trials are designed to determine the best time and method for applying the regulators.

Mandava estimates that 1 gram of either synthetic brassinosteroid would cost between $5 and $10 to produce on a commercial scale. That cost is not unreasonable since a gram would cover as much as 2 hectares. The two Beltsville scientists are now undertaking the synthesis of brassinolide and one other analog using Chesapeake Bay oysters, which provide a relatively cheap and abundant supply of steroids as a starting material.

Meanwhile, John Siddal of the Zoecon Corporation in Palo Alto and Steven Fung, now with Ayerst Pharmaceuticals in Montreal, revealed that they have synthesized brassinolide. The same feat has also been accomplished by scientists at the Tokyo Institute of Technology. Synthetic brassinolide is too expensive for use on field crops, Siddal says, but Zoecon thinks it might prove useful for certain specialized crops and for applications in biochemical research.

Brassinolide and the brassinosteroids are not without some potential problems that require further research. Because they are steroids, it is possible that they could have some undesirable effects on insects, wildlife, and perhaps even man--although Mandava is quick to point out that no indication of such effects has been observed. Furthermore, because of the high value of vegetable and other crops on which the chemicals could be used, farmers may be reluctant to try them until their value has been thoroughly proved.

Triacontanol. Prior to some current research by Andrew J. Welebir of Biochemical Research Corporation in Falls Church, Virginia, triacontanol's history has had several ups and downs. It was discovered in the mid-1970s by Stanley K. Ries of Michigan State University, who observed that placing chopped alfalfa in fields significantly increased the yield of tomatoes and other crops. When he isolated the active ingredient in 1977, he found that it was triacontanol, a constituent of beeswax and a variety of plants observed as long ago as 1934. In his initial studies, Ries reported that triacontanol produced increases of 8 to 63 percent in yields of navy beans, asparagus, sweet corn, carrots, cucumbers, radishes, and tomatoes. The growth increases were rapid and, in some cases, even occurred in the dark.

Subsequent field tests of triacontanol by Ries and by USDA, universities and chemical companies proved disappointing, however. Sometimes the chemical would produce a substantially increased yield, and sometimes nothing would happen. Many investigators gave up on the compound because it proved so unreliable. Ries attributes most of these problems to the method of formulation of triacontanol. The long-chain alcohol is very insoluable in water, and Ries and others have used detergents and surfactants to emulsify it and keep it in solution. Clearly this has not been adequate, since the inconsistent results have continued. Ries himself is discouraged and says he will work on the problem in the field for only one more season. If he has not achieved satisfactory results by then, he says, he will drop field research on triacontanol and go on to other projects.

Welebir, however, thinks that formulation is only part of the problem. Investigating the interactions of triacontanol with plant hormones, he observed that the activity of triacontanol is very sensitive to the concentration of metal ions, particularly calcium and lanthanum. He has also found that plant response occurs only when the pH of the triacontanol solution is 8 or greater. He presented some of the results of this research at an American Chemical Society meeting in March, 1981.

Even before he developed a theoretical basis for their use, however, Welebir began adding calcium or lanthanum salts to preparations of triacontanol and found not only that the regulator worked consistently, but also that he obtained better results than other investigators. He suggests that the detergents and surfactants used to emulsify the triacontanol were inhibiting the plant stimulation by their effect on calcium. He now uses a preparation of triacontanol dissolved in acetone and water; the concentration can be quite low, since it is effective when applied at a rate of 10 milligrams per acre. The cost is 2 to 4 cents per acre.

In preliminary field trials conducted last summer, Welebir found that the new formulation increased the weight of fresh sweet corn by 51 to 54 percent in three separate trials. Application to seedlings produced a 6 to 19 percent increase in ear length due to the formation of larger kernels, and an increase of 20 percent in the number of ears. Field tests with tomatoes, Welebir says, showed early increases in yields of 65 to 72 percent, while the yield of beans increased by as much as 90 percent. Preliminary results with field corn, which had shown no effects in earlier studies with triacontanol, suggest that a 15 to 20 percent increase in yield can be obtained. Many new field trials on a variety of major crops will be conducted during the coming growing season to see if the results remain consistent.

Both the brassinosteroids and triacontanol will, of course, have to be approved by the Environmental Protection Agency (EPA) before they can be used on a commercial basis in the United States. Welebir, for one, sees little problem with this, since "triacontanol is ubiquitous in nature; corn tissue contains about 235 micrograms per gram, compared to the low nanogram levels each plant receives." Brassinolide also appears to be present in a large number of species. These new growth promoters, and others like them that seem certain to follow, should prove very valuable to agriculture.

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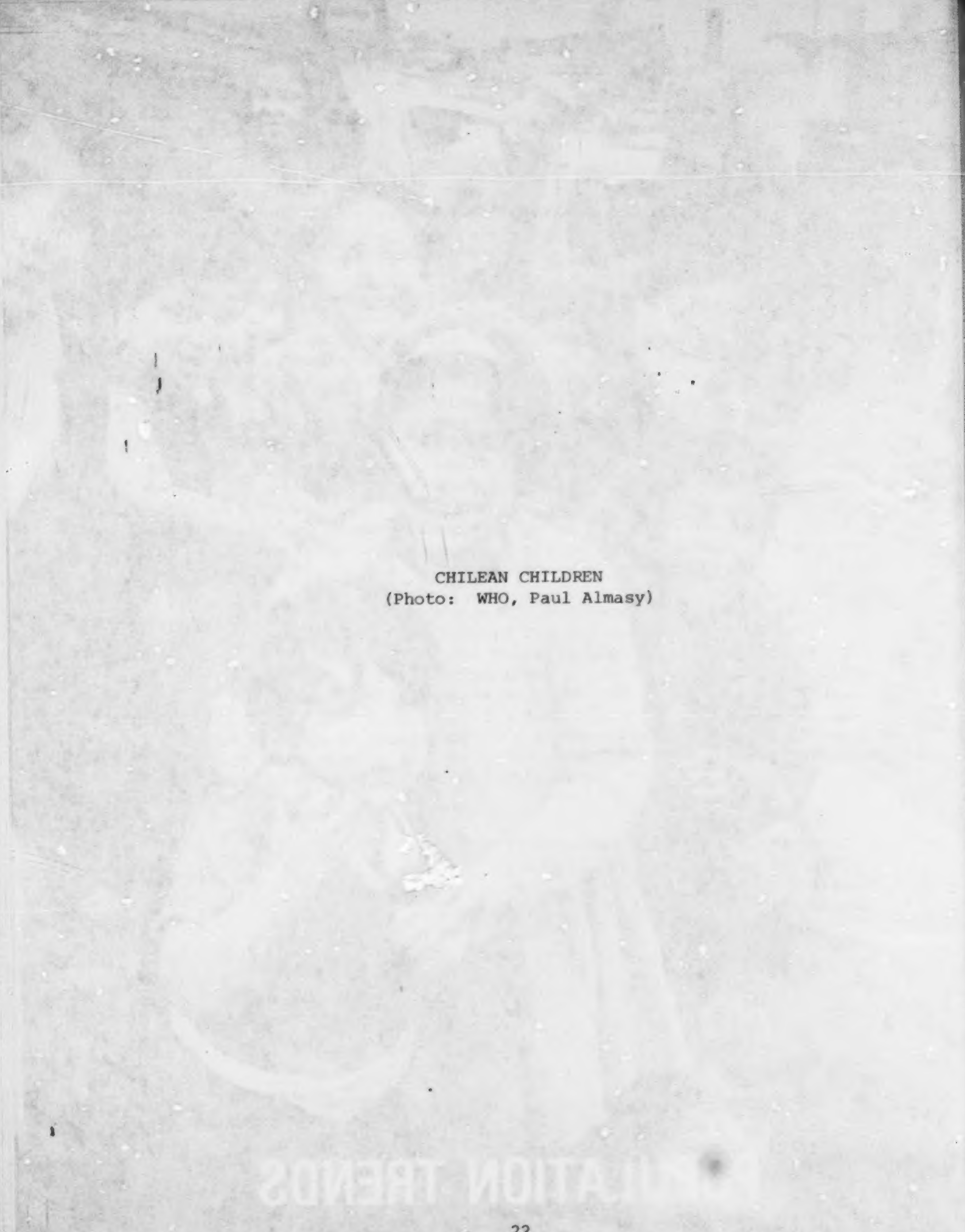
POPULATION TRENDS



CHILEAN CHILDREN
(Photo: WHO, Paul Almasy)

Population Trends and Prospects

W. Parker Mauldin

[For the next 20 years there is likely to be a slowing of population growth rates for all areas of the world except Africa. The present population of developed countries is expected to increase by about 12 percent by the year 2000; that of developing countries is expected to increase by about 50 percent. The momentum of population growth is strong; a few analysts suggest that world growth may cease at 8 billion, but a figure of more than 10 billion seems much more likely.]

The population of the world increased by 75 percent in the past 30 years, from 2.5 billion in 1950 to 4.4 billion in 1980. In 1950, one-third of the population lived in developed countries--Europe, Northern America, the Soviet Union, Japan, and Australia--and two-thirds lived in developing countries. The increase during this period was quite small in Europe, an increase of 23 percent. The United States and the Soviet Union grew at slightly less than 50 percent. The developing countries grew much more, both in numbers and rates; their populations almost doubled, increasing from 1.7 to 3.3 billion. The change was most rapid in Latin America with an increase of 125 percent, from 164 million to 368 million. Africa also more than doubled its population, from 219 million to 469 million (+114 percent). In 1950 the population of Asia numbered almost 1.4 billion, and today it is 2.6 billion, an increase of 85 percent.

The prospects until the year 2000 are for a slowing of growth rates for all areas except Africa, but the numbers to be added will be enormous. Population projections of the United Nations anticipate a rapid slowing of population growth in the developed countries, an increase

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of less than 8 percent in Europe, about 17 percent in the United States and the Soviet Union, and about 12.5 percent for all developed countries. The less developed countries are likely to increase their population by one-half: Africa 76 percent, Latin America 65 percent, South Asia 55 percent and East Asia 24 percent. Thus, half a century's growth may well show an increase in the population of developed countries of just over one-half the 1950 numbers, from 832 to 1,272 million. In the developing countries the increase will be far greater, from 1.7 to 4.9 billion.

Adequacy of Data

There is much that we do not know about the world's population size and growth. Our best estimate is that the population of the world is about 4.5 billion, but that figure could be in error by 200 million--and is likely to be too low rather than too high. We cannot be sure, for example, that China's population is within the range of 950 to 1,000 million (its census in 1982 will give a more reliable figure), or that Nigeria's population is within the range 70 to 85 million. Even in the United States the net undercount of the census is about 5 to 7 million, and for the most part the census figure is used although a larger figure is known to be more nearly correct. Fertility and mortality rates are particularly deficient for Black Africa, and for many countries we do not know whether fertility rates are going up or down--or, more likely, are changing hardly at all. Knowledge about mortality rates is in some respects even more deficient, and again, particularly for Black Africa. Despite the lack of precise information, however, a great deal is known about population size and growth and about mortality and fertility trends. There have been major improvements during the past 15 years or so in the collection of data, both through censuses and sample surveys, and in analytical techniques. For convenience, and with no great loss in accuracy, for the most part I shall use the United Nations' projected figures for 1980 to describe current levels.

Mortality

The very large increase in population during the past several decades is primarily the consequence of a very rapid decline in mortality throughout the world. With today's population we would have more than 80 million deaths a year if 1950 mortality rates were unchanged, instead of fewer than 50 million that result from today's population and mortality rates. In 1950, life expectancy at birth was about 65 years in developed countries, and perhaps 42.5 years in developing countries. Today it is 7 years more for developed countries, and perhaps 13 years more in developing countries, or about 72 and 55-56 years respectively. The gain has been largest in developing countries, but the gap between the two groups of countries remains very large.

Mortality rates are highest in Africa, particularly Black Africa, although life expectancy at birth increased by 12 years, from about 38 in 1950 to almost 50 today, and the crude death rate dropped from almost 27 to 16 per 1,000 per year. Infant mortality remains very, very high, perhaps 200 or more per 1,000 per year in Black Africa and about 150 in North Africa. The figures for South Asia are comparable. Life expectancy was just under 40 years in 1950, and today is about 53; the crude death rate decreased from about 25 to 13.3. Life expectancy in East Asia is 65 to 66 years, a remarkable increase of 18 years from 47.5 in 1950. Life expectancy in Latin America also registered major gains from 52 to more than 64 years.

The lowest crude death rates, around 5 per 1,000, are found in some of the developing countries such as Taiwan, South Korea, Hong Kong, and Singapore, rather than in developed countries. This is so despite the fact that in developed countries death rates are lower age-for-age than in the developing countries. This apparent anomaly results from the combination of the large proportions of persons in the young age groups and low proportions of older persons in the developing countries. The reverse is true in developed countries; mortality rates are quite low in the young ages such as 5 to 20, and of course are high in the older ages. The result is that in developed countries crude death rates are almost double, or about 10 per 1,000 per year.

Although the largest improvements in mortality rates during the past three decades have been made in developing countries, the improvements in developed countries are also significant. Declines in infant mortality in developed countries have been remarkable. In 1950, very few countries had infant mortality rates under 25 per 1,000 per year, and many had rates ranging up to 50, and more. Today, six countries have rates below 10, and 25 countries have rates below 20. (The United States has a rate of 13-14).

Curiously, the causes of these very large changes in mortality are not well known. The increases in the number of physicians and other medical personnel, and of medical facilities, have not been sufficiently large or rapid to account for much of the change. Preston's analysis concludes that only 16 percent of the change from the 1930s to the 1960s was attributable to improvements in economic conditions. He also concludes that improved nutrition was not a major cause of the decline. Lacking even reasonably hard evidence, students of these changes have come to say that the reduction in mortality rates is due to a combination of causes such as improved communication and transportation, more responsive governments, improved sanitation, the widespread use of the insecticide DDT, and the availability of antibiotics. Currently, there is controversy as to whether mortality declines have slowed appreciably [discussed in another article below].

Mortality differentials are at least as great within countries as among different countries. Studies in Asia, Africa, Latin America, and the United States show that child mortality is two to five times as high among mothers with no education as among mothers with high school education. Differentials increase as education of the mother increases. Mortality differentials are also associated with other socioeconomic indices such as income, but the differentials are particularly strong with education of the mother.

Fertility Trends

Overview. The crude birth rate of the world was about 36 births per 1,000 population per year in 1950; it has been reduced by about 20 percent and is below 30 today. But the world is divided into high and low fertility countries, with the developing countries having both high fertility and the bulk of the population (74 percent, or 3.3 billion persons).

The more developed countries had low fertility in 1950, an average crude birth rate of about 23, but there has been a remarkable decline in fertility in almost all developed countries since then. The average decline has been almost one-third, and the level of crude birth rates today is about 16 (Fig. 1). A few of the developed countries have

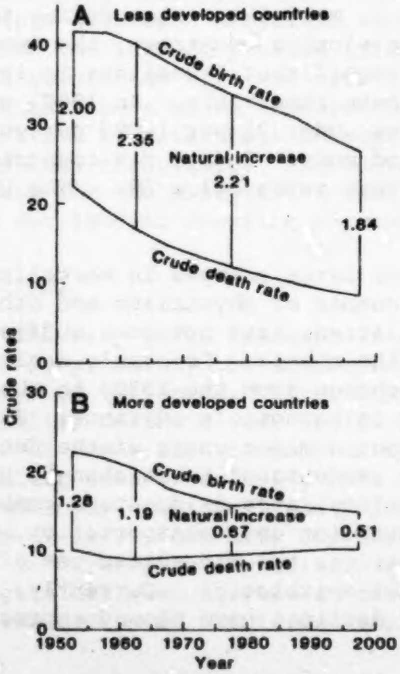
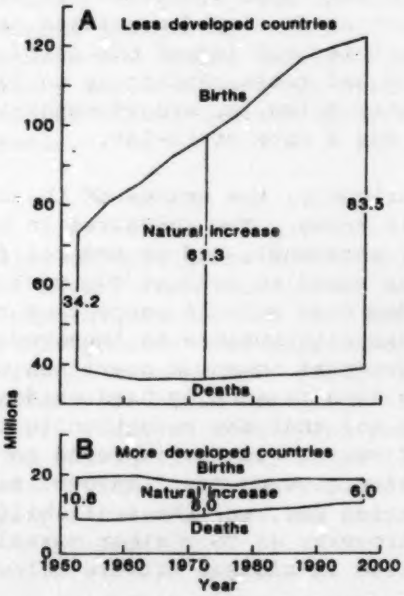


Fig. 1. Crude birth and death rates and percentage natural increase, 1950 to 2000 (United Nations medium assumptions).



Average annual number of births, deaths, and population increase, 1950 to 2000 (United Nations medium assumptions).

more deaths than births (both of the German states), and many have rates of reproduction that if continued would result in no or negative growth. The average rate of growth of population among these countries is well under 1 percent, and is likely to decrease further during the next few decades. Thus, population growth among the more developed countries poses few problems in terms of maintenance of current levels of living.

The developing countries present a different picture. In 1950 their populations numbered 1.7 billion, and death rates were high, more than 23 per 1,000 population per year. The revolution in mortality has almost halved the crude death rate to 11 or 12 today. Fertility was high in 1950, about 42 per 1,000. Thus, the rate of growth was slightly less than 2 percent per year in 1950. Major changes in fertility have also occurred in many developing countries, though overall fertility changes have been less marked than the decline in mortality. The figures show a decline in the crude birth rate from 42 to 33--a decrease of 9 points, or about 20 percent. Changes in fertility have been dramatic in Asia and the Pacific, substantial in Central and South America, and hardly noticeable in Africa. In Asia, where the bulk of the population lives, the crude birth rate declined by 25 percent from more than 41 to 31 per 1,000 population per year. In the Americas the decline was 16 percent--from more than 41 to less than 35 per 1,000 per year. The data for many African countries are woefully inadequate, and birth rates and trends may not be accurately reflected in the figures available, which suggest a crude birth rate of about 48 in 1950, and perhaps dropping a couple of points to 46 in 1978. Only two countries in Africa-Tunisia and Mauritius--have had appreciable changes in fertility over the 30-year period. Egypt had a decline in its crude birth rate in the late 1960s and very early 1970s, but since that time the crude birth rate has increased. Most of the changes in its crude birth rates are attributable to changes in the number of persons marrying; a small part of the change is due to a modest decline of 7 to 8 percent in marital fertility from the mid-1960s to the mid-1970s.

Developed countries. All developed countries experienced fertility declines from 1950 to 1978 except Ireland and Argentina. Declines ranged from about 10 percent in Spain to more than 40 percent for five countries. Overall, fertility declined by 32.3 percent in developed countries. The two largest developed countries, the Soviet Union and the United States, had similar rates at both periods, with the United States having slightly lower rates in both years. Decreases in fertility rates were common to large and small countries, to capitalist and socialist, to European and non-European populations, to Catholics and Protestants.

The current levels of fertility are remarkably low for almost all of the developed countries. The Federal Republic of Germany has a birth rate of less than 10, well below the replacement level, and 13 additional countries in northern and western Europe have rates of less than 15. All of these countries plus Canada, the United States, and Japan have below-replacement levels of fertility. A few of the 35 developed countries do not have low fertility: Albania, with a crude birth rate of 33 per 1,000 population per year when last reported, and Israel and Argentina, with rates of 25, are the major exceptions. Ireland and Uruguay also have crude birth rates around 21. All other developed countries have crude birth rates of less than 20 per 1,000 population per year.

While most developing countries are seeking to reduce their birth rates, Eastern European countries, where legalized abortion came to be associated with, or indeed produced, a quite low birth rate, are now making determined efforts to increase theirs, with occasional signs of success. Negative measures include tightening of restrictions relating to induced abortions and reduction in the availability of contraceptives. Positive measures are a liberal increase in monthly wages for couples having three or more children, interest-free loans for purchase of an apartment or house and of household furnishings with, for example, 20 percent of the loan being cancelled at the birth of the first child, 30 percent for the second, etc. In addition, some other developed countries have pronatalist ambitions or milder policies: Israel, France, Finland, Greece and Argentina. The Netherlands reports the goal of achieving a stationary population, and Japan, that a stationary population is "estimated and expected."

Developing countries. There are 92 developing countries with a population of 1 million or more, but 2.6 billion, or 80 percent of the population of all developing countries live in 16 countries. Population data, crude births rates, and percentage changes for 1965 and 1975 are given for those countries in Table 1 (excluding Vietnam for lack of data). These countries vary enormously in ethnic origin, culture, level of development, population policy, and changes in fertility. Brazil and Nigeria do not seek to reduce the rate of population growth, but in recent years have adopted a policy of supporting family planning for reasons of health and as a human right. Iran had a policy to reduce its rate of population growth, but it is unlikely that the present government will continue that policy. Burma has a pronatalist attitude. It recognizes family planning as valid on maternal and child health grounds, but contraceptives are not easily available; the importation of contraceptives is illegal and family planning clinics are not allowed. All the other countries have adopted policies to reduce the population growth rate.

There has been no significant reduction in fertility in Bangladesh, Burma, Iran, Pakistan, or Nigeria, but there is evidence of change in each of the other ten countries. The decline has been particularly strong (more than 25 percent) in China, South Korea, and Thailand,

Table 1 Crude birth rates and crude birth rate decline for 1965 (or later) in less developed countries with populations of 35 million or more.

Country*	1980 population (millions)	Crude birth rate		Percentage change in crude birth rate 1965 to 1975 (or later)
		1965	1975 (or later)†	
China	975	34	22^8	−35
India	694	43	36	−16
Indonesia	152	46	36	−22
Brazil	122	42	33^7	−21
Bangladesh	89	48	48	‡
Pakistan	82	47	47	‡
Nigeria	77	49	49	‡
Mexico	70	44	37^8	−16
Philippines	51	44	34^7	−23
Thailand	48	44	33	−26
Turkey	45	40	34	−16
Egypt	42	41	37	−10
Iran	38	45	45	‡
South Korea	38	32	22	−29
Burma	35	40	40	‡
Total	2523	40	33	−20

*Excludes Vietnam with an estimated population of 52 million; information on vital rates over time is not thought to be reliable. †The crude birth rates are for 1975 unless a later year is specified with a superscript 7 or 8 for 1977 and 1978, respectively. ‡No significant change.

and has also been quite impressive (more than 20 percent) in Brazil, Indonesia, and the Philippines. The data on which these estimates are based are quite recent for several countries including Brazil, Mexico, and the Philippines.

The rate of population growth in developing countries is down from its recent peak, but not by much (Table 2). It is now about 2.2 percent per year with a country range from about 1 percent to well over 3 percent. Fertility declined more rapidly than mortality after 1965 in Asia and Latin America, and the rate of natural increase was smaller in Latin America and much smaller in Asia during the last 5 years than during 1960 to 1965. Fertility and mortality declines were about equal in North Africa and the Middle East, but in sub-Saharan Africa fertility did not decline whereas mortality probably did, and thus the rate of natural increase there continued to climb to an estimated 2.9 percent per year.

Table 2 Rates of population growth.

Area	Percentage of natural increase			Percentage change 1960 to 1965/ 1975 to 1980
	1950 to 1955	1960 to 1965	1975 to 1980	
World	1.77	1.99	1.81	− 9.0
More developed	1.28	1.19	0.67	−43.7
Less developed	2.00	2.35	2.21	− 6.0
Africa	2.16	2.49	2.91	+16.9
Latin America	2.72	2.77	2.66	− 4.0
Asia	1.88	2.06	1.37	−33.5

The net effect of these differing trends in the developing countries was a modest decrease of about 6 percent in the rate of natural increase, from 2.35 percent in 1960-65 to 2.21 percent in 1975-80, according to the United Nations. Fertility decreases were significantly larger, a decrease from 40.0 to 33.6, or -16 percent. Mortality rates also declined from a crude death rate of 16.8 in 1960-65 to about 12 during the past 5 years. In developed countries there has been a continuing decrease in fertility, but mortality rates have more or less stabilized for the present--the countervailing product of continuing improvement in mortality offset by population aging. Rates of natural increase have thus fallen with fertility decline and are now only about two-thirds of 1 percent per year. But the demographic momentum in the developing sector remains particularly strong, regardless of any realistically favorable developments of the next years.

China's reconciliation of a Marxist "theory" of population with "planned" population growth has attracted attention due to the sheer magnitude of its population. Recognition that rapid population growth is detrimental to the economy of China did not come easily or quickly. In June 1957, Professor Ma Yinzhu, an economist, then president of Beijing University, published a "New Population Theory," arguing that population growth in China should be controlled. He was denounced in the press, and in 1960 was removed from his university position. By 1974, however, Chinese officials had begun talking about the need for planned births as well as planned production. In March 1978 the Chinese announced that their goal was to reduce the annual rate of population growth to less than 1 percent within 3 years. In July 1979, a public apology was made to Professor Ma, and he was officially told that "the two criticisms of your new population theory before 1958 and after 1959 had both been erroneous."

The official view in China today is that population growth has been, and is, too rapid, and must be reduced. The stated goal is to reduce the rate of growth from 1.2 percent in 1978 to 0.5 percent in 1985 and to zero by the year 2000. Population growth is viewed as being detrimental to the development of the economy because it decreases the speed of capital accumulation; it hinders the rapid elevation of the scientific and cultural level of the entire population, and it is detrimental to the improvement of the people's livelihood. China seeks to lessen rates of population growth through late marriage, the availability of abortion and contraceptive services, emphasis on planning the number of children born each year, and recently, a campaign strongly advocating a one-child family. Decreases in rates of population growth are to be achieved by mobilization of party committees on all levels; strengthened propaganda and education; by a system of awards and penalties inducing conformity to the stipulated fertility norms; and by improving family planning services and programs.

Most estimates of the population of China fall within the range of 950 million to 1,000 million, but a reasonably firm figure must await the 1981 census. The Chinese announced a crude birth rate of 18.34 and a death rate of 6.29, and thus a growth rate of 1.2 percent, in 1978. These figures are said to be estimates derived from incomplete data. Whatever the precise figures, it is evident that China has achieved a remarkable improvement in health conditions and in the reduction of fertility.

South Korea and Thailand have had crude birth rate decreases of more than 25 percent since 1965, although Thailand's current rate is still moderately high, in the low 30s. South Korea has had a rapidly growing economy and also a vigorous family planning program since the early 1960s. Thailand has had less rapid economic development but has had a sustained, moderately strong family planning program.

Indonesia has a very low per capita income, a low rate of economic growth, and high fertility. It is thought that fertility changed but little from 1950 until the late 1960s; but there are changes since that date. In 1968 Indonesia embarked on a large-scale family planning program which has been well organized since 1970; indeed, it is commonly thought to be one of the most vigorous family planning programs in the world. The number of family planning acceptors has been very high, particularly in Java and Bali. With the large number of family planning acceptors, one would expect some decrease in fertility. There is considerable lag between collection of data from sample surveys and detailed analysis of the results; and there is controversy as to how much Indonesia's fertility has fallen, but certainly it has fallen during the 1970s.

India is among the poorest countries in the world and, despite ambitious development plans starting in the early 1950s, per capita income and many other indices of development remain low. India was the first country in the world to adopt a population policy designed to reduce rates of population growth in 1952. A relatively small family planning program in the 1950s was expanded to a large-scale program in the mid-1960s. The family planning efforts have been heavily dependent on male sterilization in some states. Strong pressure, and apparent coercion, led to a tremendous increase in the number of sterilizations in 1976, and these strong measures were a principal factor in the subsequent overthrow of the government.

The evidence is unmistakable that fertility has fallen significantly in India during the past 15 years even though the level of fertility is not known with precision. The current level of the crude birth rate, estimated at 36 per 1,000 population per year, is known with more accuracy than the rate during the early and mid-1960s. The level at the earlier dates may have been closer to 45 or 46 than to the 43 shown in Table 1.

This account is concentrated on large countries because that is where most of the people of the world live. Fertility declines in smaller countries have often been near spectacular, and some of these have been highly publicized. Fertility declines in Hong Kong (36%), Singapore (40%), and Taiwan (30%), are frequently mentioned, but equally impressive declines have occurred in Cuba (40$), Mauritius (29%), Chile (29%), Colombia (25%), Panama (22%), and Costa Rica (29%).

The causes of recent fertility declines, in both developing and developed countries, will probably remain in some dispute for at least several years; such is the nature of causal analyses of highly complex circumstances. But some degree of consensus seems to be emerging to the effect that:

1) Marital patterns (age at marriage, proportion of reproductive age spent within marriage) account for a substantial part of the recent decline, perhaps 35 to 45 percent in developing countries; but marital fertility itself is the major component.

2) Social setting or development level has a substantial relationship to fertility decline, certainly on a holistic basis and probably selectively with regard to health and educational status.

3) Family planning programs have a significant independent effect, certainly in developing countries with favorable social settings, and also under certain conditions in countries with less favorable settings (including the three largest: China, India, and Indonesia). Moreover, the longer the program and the clearer its demographic intent, the greater its effect.

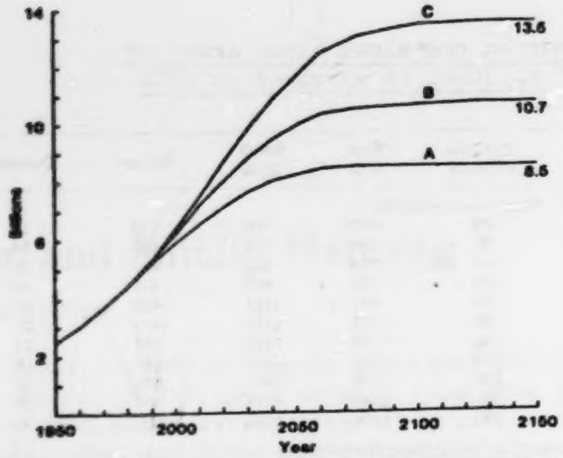
4) Social setting and family planning programs together predict or "explain" (statistically) a large part of fertility decline.

Prospects

Despite the uncertainty about predicting the future, there is consensus on several major points:

1) Growth rates in developed countries are low, and it is likely that they will remain so. Fertility could increase, but the two-child family seems to be more nearly the norm than a three-child family. The present population of developed countries is just over 1.1 billion; 20 years from now it is likely to be less than 1.3 billion. Few serious analysts disagree with this generalization.

2) Growth rates in developing countries are high. These will be moderated somewhat during the next two decades, but the momentum of population growth is high, and this momentum will lead to larger and larger absolute increases in the population of the developing countries during the remainder of this century even though fertility rates continue to decline (see Figs. 1 and 2). This momentum of population growth is



If the world attained replacement fertility in	World population would then stand at	And world population could be expected eventually to stabilize at
(A) 2000-2005	5.9 billion (2000)	8.5 billion
(B) 2020-2025	8.0 billion (2020)	10.7 billion
(C) 2040-2045	10.8 billion (2040)	13.6 billion

Fig. 2 Momentum of world population growth. The fertility decline is assumed to begin in all cases with the 1975 to 1980 level of population growth. Thus, replacement-level fertility (2.1 to 2.5 births per woman) by 2000 to 2005, for example, implies a gradual reduction of fertility over a 20-year period. [From (23)]

caused by an age structure with a relatively large proportion of young persons who will move into and increase the number in the reproductive ages for at least 15, and more likely more than 20, years.

3) Most population projections for the year 2000 cluster around 6 billion. The United Nations produces three projections; just under 5.9 billion, 6.2 billion, and 6.5 billion. Thus, it is projected that the population of the world will increase by about 1.4 billion to 2.0 billion during the next 20 years. Most analysts favor figures that imply a growth of 1.5 billion ± 200 million.

4) The medium assumption of the United Nations projects a population increase of 40 percent by the year 2000. Africa is expected to have the most rapid growth, more than 75 percent, and Latin America the next most rapid with about 65 percent growth. South Asia would grow by 55 percent and East Asia by 24 percent according to these projections. Northern America and the Soviet Union would grow by 17 to 18 percent. Europe would grow very slowly, by only 7 percent. The record of population growth since 1950 by major areas, and projected growth until the year 2000 are shown in Table 3.

5) There is lack of agreement as to when fertility will begin to decline, and at what rate, in Black Africa, Bangladesh, and Pakistan.

6) Nor is there agreement as to what the size of the world's population will be when it ceases to grow. A few optimistic analysts set

Table 3. Population trends in the eight major areas of the world, 1950 to 2000, as assessed in 1978

Year	World	Africa	Latin America	Northern America	East Asia	South Asia	Europe	Oceania	Soviet Union
				Population (millions)					
1950	2513	219	164	166	673	706	392	13	180
1955	2745	244	187	182	738	775	408	14	196
1960	3027	275	215	199	816	867	425	16	214
1965	3344	311	247	214	899	979	445	18	231
1970	3678	354	283	226	981	1111	460	19	244
1975	4033	406	323	236	1063	1255	474	21	254
1980	4415	469	368	246	1136	1422	484	23	267
1985	4830	545	421	258	1204	1606	492	24	280
1990	5275	630	478	270	1274	1803	501	26	292
1995	5733	726	541	281	1340	2005	510	28	302
2000	6199	828	608	290	1406	2205	520	30	312
				Average annual rate of increase (percentage)					
1950 to 1955	1.77	2.16	2.72	1.80	1.85	1.86	0.79	2.25	1.71
1955 to 1960	1.95	2.36	2.78	1.78	1.99	2.24	0.84	2.18	1.77
1960 to 1965	1.99	2.49	2.77	1.50	1.94	2.44	0.90	2.09	1.49
1965 to 1970	1.90	2.61	2.67	1.11	1.75	2.52	0.66	1.96	1.09
1970 to 1975	1.84	2.71	2.64	0.87	1.62	2.45	0.61	1.82	0.84
1975 to 1980	1.81	2.91	2.66	0.83	1.32	2.49	0.39	1.47	0.94
1980 to 1985	1.80	2.97	2.65	0.96	1.16	2.44	0.36	1.41	0.94
1985 to 1990	1.76	2.93	2.58	0.91	1.14	2.31	0.35	1.37	0.85
1990 to 1995	1.66	2.81	2.46	0.76	1.01	2.13	0.37	1.30	0.70
1995 to 2000	1.56	2.64	2.34	0.61	0.95	1.91	0.38	1.19	0.64

Source: United Nations, World Population Trends and Prospects by Country, 1950-2000, Summary of 1978 Assessment (New York, 1979).

the figure around 8 billion, but a population of 10 billion to 12 billion seems more realistic. For example, if replacement fertility were reached in every country of the world by the year 2000 the population would grow to 8.5 billion (see Fig. 2). But such a rapid decline in fertility seems very unlikely. If replacement fertility were achieved by the period 2020 to 2025, the population of the world would grow to 10.7 billion. If the achievement of replacement fertility were further delayed, say to the period 2040 to 2045, the population of the world would grow to 13.5 billion. There seems to be an emerging consensus that if the leaders of the major developing countries view rapid population growth as an impediment to economic development and act accordingly, and if the donor community also continues and perhaps increases assistance to such countries, the population of the world might plateau around 10 billion. But larger numbers are all too possible.

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Men and Family Planning

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[The major targets of family planning programs over recent years have been women. Partly this results from some prevailing attitudes of men, partly from males having less attractive contraceptives than those for females. Men and women ought to share their family responsibilities. The following article discusses the role men can take in family planning.]

Men are the forgotten sexual partner in family planning programs. Despite the fact that conceiving a child always involves two people, society often ignores the interest men have in planning their families. Male contraceptives are treated as second-class birth control methods, and in many countries their advertisement is banned. Until recently, there has been little research into new male methods of birth control. And few organized family planning programs have targeted men as clients.

Men's potentially positive role in family planning has so often been neglected because of the negative attitudes many men hold toward birth control. In the industrial world, men frequently use the availability of effective female contraceptives as an excuse for not using any birth control themselves. In the Third World, some men still insist on having the sole right to decide whether and when to have a child; many deny their wives access to contraception because they fear it will encourage promiscuity. And everywhere there are men who oppose birth control and women's changing roles in society, possibly because it takes from them their power to father an unlimited number of children and seems to leave them with a diminished position in the family.

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Society can ill afford to have men play this peripheral or negative role in family planning. The world faces the daunting prospect of supporting 10 to 12 billion people by the middle of the next century unless birth rates fall rapidly. More than half the world's couples do not use contraception, and they are concentrated in the poorest parts of the Third World. Many of these societies are patriarchal, and men still dominate family decisions. The ultimate success of birth control programs in these countries may rest on the availability and use of effective male contraceptives and the involvement of men in family planning programs.

The health of both men and women could improve if men play a greater role in birth control. There is clear evidence now of various health risks posed by women's prolonged use of oral contraceptives or an intrauterine device (IUD). Condoms, however, relieve women of these problems without creating a health problem for men. Increased reliance on condoms could also help curb the spread of sexually transmitted diseases, as compared to reliance on the major female contraceptive methods.

Until two decades ago, most couples used male contraceptive methods, if they used any at all. With the introduction of the pill and the IUD, female birth control methods soon became dominant. Now the pendulum seems poised to swing back, and men and women may soon share more of the responsibility for contraceptive use. In the United States, condom sales are already on the increase. Several Asian countries have expanded their vasectomy programs, and recent progress in making the operation reversible bodes well for vasectomy's future acceptability. A male contraceptive pill might be on the market by the end of the century. And male family planning programs have struck a responsive chord in the United States as well as in parts of the Third World. These changes hold the promise of men participating more actively in family planning: by using effective male contraceptives, by supporting women in their choice of birth control, men can assume a larger share of the burdens of contraception and the joys of having children.

Male Contraception: Traditional Methods

Of the more than 250 million people in the world currently using some method of birth control, about one out of three rely on male contraception. This portion has steadily decreased in recent years as the pill, the IUD, and female sterilization have become widely available. Yet male birth control is anything but obsolete. Some 37 million men use condoms, about 35 million have had vasectomies, and millions more rely on withdrawal. By comparison, each of the major female methods has 50 to 65 million users worldwide (see Table 1).

Figures such as these mask a curious geographic split in male and female contraceptive use around the world. The small number of couples in the Third World who use birth control overwhelmingly prefer female methods, despite the fact that male methods have been in use longer and often are simpler and cheaper. Most of the people who rely on male contraception live in industrial countries. One out of five Americans, one out of two Italians, and four out of five Japanese use a male method of birth control regularly.

Table 1: ESTIMATED NUMBER OF PEOPLE USING MAJOR BIRTH CONTROL METHODS, 1980

Method	Number (Millions)
Female Methods	
Sterilization	65
Oral Contraceptives	58
Intrauterine Device	52
	175
Male Methods	
Condom	37
Vasectomy	35
	72

Source: Agency for International Development.

Condoms enjoy their greatest popularity in Japan, where 79 percent of married couples rely on them or have done so in the past, often in conjunction with the rhythm method. Condoms are also quite popular in the United Kingdom and Sweden, but are little used in most developing countries. Vasectomies, on the other hand, are widespread in both the United States and India. More than 10 percent of all married American men of reproductive age have been sterilized. And since 1966 more than 20 million Indian men have had vasectomies. Elsewhere, the operation is relatively rare.

A closer look at each of the major male methods sheds some light on cultural and geographic differences in birth control use. Withdrawal, technically known as coitus interruptus, is one of the oldest means of family planning, male or female. The Book of Genesis in the Christian Bible refers to Onan, who spilled his semen on the ground. More specifically, Islam permits withdrawal provided that the woman gives her consent. Throughout its long history, coitus interruptus has been a much maligned means of preventing births. It has the highest failure rate of any major method of contraception. In addition, the interruption of sexual activity necessitated by withdrawal can markedly diminish the physical pleasure of both partners. It also requires the man to be responsible at the moment his resolve may be the weakest, and asks the woman to place her full trust in that resolve.

Yet withdrawal costs nothing, it involves no creams, pills, or devices that can be inadvertently forgotten, and it does not require a medical prescription. Moreover, withdrawal's demographic record as a family planning method is noteworthy. The falling birth rates in nineteenth century Europe, and more recently in Eastern Europe, were in large part the result of coitus interruptus backed up by abortion. When practiced in conjunction with other more effective methods or when combined with periodic abstinence during a woman's most fertile periods, withdrawal can indeed be a successful means of birth control.

Like withdrawal, the condom has seldom been treated seriously as a contraceptive. The historical association with venereal disease has long linked the condom with "illicit sex." A gentleman, it was thought, would use one with a prostitute but certainly not with his wife. Yet the data on condom usage belie this image. Until the mid-sixties the condom was the principal method of birth control in the United States. With the advent of the pill and the IUD, condom sales fell and by the mid-seventies, only 7 percent of all married couples were using condoms. Since then, however, the condom has experienced something of a revival and Americans bought about a half billion of them in 1980.

The nature of the condom may in the long run be its biggest drawback. At least since Casanova's day, men have complained that condoms reduce sexual sensation. Thinner condoms and ones made of different materials could remedy some of these problems; a tough elastic membrane that could transmit heat and tactile stimulation is needed. It is also possible that by the end of the century a more effective spermicide-coated condom or a contraceptive film that would cover the tip of the penis could be available. These innovations could undoubtedly make the condom a more attractive contraceptive option. In any case, as researchers who have studied human sexuality often point out, the pleasure connected with sexual activity stems more from the attitude of the two people involved than it does from penile sensation, so condom use does not have to limit sexual fulfillment.

The number of condom users is certain to increase in the years ahead. Commercial condom distribution is expanding, especially in the Third World. Concern about the health effects of women's use of the pill or the IUD will lead many couples to rely on the condom, often in conjunction with other female methods. The rising incidence of venereal disease is already encouraging many individuals who have several sexual partners to protect themselves by using condoms.

Vasectomies. In the last decade, the most dramatic change in male contraceptive use has been the threefold increase in the number of vasectomies. This simple operation involves an incision in the scrotum to cut or block the vas deferens, the two tubes that carry semen from the testes to the penis. In the United States, over 700,000 American men had had vasectomies in 1971. By the end of the decade, however, nearly six million men had been sterilized, and more couples relied on male than on female sterilization as their method of birth control.

Outside the United States, India was one of the first countries to use vasectomies in its national family planning program, and with dramatic success. Some observers ascribe the popularity of vasectomy to Hindu culture: for many Indians, there is great virtue in celibacy, in part because it is believed that men enhance their strength and power by withholding their sperm. Sterilization, many men may think, confers the same benefits without having to forgo sexual relations. The vast majority of Indian sterilizations have been voluntary. But in 1976 the government made sterilization the cornerstone of a crash campaign to slow the Indian birth rate. Within 12 months, six million vasectomies were performed along with about two million female sterilizations. Police and administrators at times coerced people into having a sterilization merely to meet local quotas. Opposition to these practices rose sharply and helped overturn the government. Nevertheless, by 1979-80 interest in this male birth control method had revived and about 460,000 Indian men voluntarily had vasectomies.

Many men have sincere personal anxieties about sterilization. They mistakenly worry that after the operation they will lose interest in sex and become impotent. A more difficult problem may be the growing uncertainty about the operation's long-term physical side effects. When sperm can no longer move through the vas deferens, they often pass into the blood stream and stimulate an immune reaction. The health consequences of the presence of sperm antibodies in the blood over a long period of time are unknown; only further research will determine whether they will lead to any higher incidence of health problems in old age.

Probably the main objection most people have to vasectomy is that the operation is permanent. Although some studies suggest that most vasectomies can be reversed through microsurgery, the technique has been tried on a relatively small number of men. Moreover, the procedure is complicated and expensive, so it is unlikely that adequate reversal facilities will soon be widely available, especially in the Third World. Researchers are now trying to design a plug or a valve to implant in the vas deferens that would make reversal easier. Studies are also under way with a chemical sterilization by injection. But it will be years before any of these methods are available, if ever. For the time being, men contemplating sterilization must consider the decision a permanent one.

The number of men who have had vasectomies is likely to increase substantially by the end of the eighties. China and several other countries in Asia and Latin America are expanding their male sterilization programs. Studies by Charles Westoff and James McCarthy of Princeton University suggest that as members of the American postwar baby boom generation complete their families, as many as 30 percent of the men will choose to be sterilized.

Family Planning Programs for Men

Despite the fact that men have practiced birth control for years, they have generally been excluded from organized family planning programs. However, the assumptions that shaped exclusively female family planning services have begun to change. Today, women argue that men should share the nuisance as well as the health risks of contraception. And some men have suggested a holistic approach to family planning, one that would include a range of male reproductive health services. Family planning officials and governments now have little excuse for writing off half the world's contraceptive audience.

To date, however, only a small number of male family planning programs have emerged, the great majority of them in the developed countries. Some provide traditional clinical reproductive health services. Others concentrate on increasing the availability of condoms. The most innovative programs attempt to reshape men's attitudes toward family planning and a range of related issues. There are not yet enough projects to draw definite conclusions, but existing efforts offer insights into some of the difficulties and the advantages of involving men in planning the number and spacing of their children.

In the early seventies, an attempt was made in Ghana to improve methods of providing rural primary health care, which included family planning. Mobile family planning teams traveled from village to village providing family planning services in the Danfa region north of the capital city of Accra. Their work was supplemented by the staffs of maternal-child-health centers and by village-based primary health care workers. Although the project started out as a traditional, female-oriented program, it soon became more of a male effort when nearly half the clients were men. Over half of these even requested foam, indicating that many preferred to have their partners use birth control rather than use male methods themselves. In the male-dominated society of Danfa, men often turned out to be more conscientious about the use of birth control than women. They also proved to be better family planning advocates; more men than women tried to persuade their friends to use contraception. And men who chose a birth control method either for themselves or for their partners reported that their partners had fewer pregnancies than the women who participated directly in the program.

By the time the project concluded, contraceptive use in the Danfa region had increased somewhat and fertility had fallen in some areas. While there is some controversy over interpretation of the data, an evaluation of the program by the School of Public Health at the University of California at Los Angeles suggests that at least one-half the fertility reduction in Danfa is related to male acceptance of birth control for themselves or for their partners.

The results of the Danfa program have several explanations. According to the mores of the area, men have some financial and social responsibility for children born out of wedlock. Thus the use of condoms permits some premarital or extramarital sexual activity without subsequent obligations. Moreover, educational and work opportunities for men are increasing in the area. Men, like women, seem to want smaller families when it is clear this will improve their opportunities for a better life for themselves and their families. When the men of Danfa were asked to explain for themselves why they chose to practice contraception, their responses expressed a remarkably unselfish concern. The most common reason given was the improvement and preservation of the health of their children. Men were also concerned with protecting their wives' health and with making it easier to educate their existing children.

The Danfa program demonstrates that medically oriented male family planning programs can increase men's use of contraception. In fact, the men in Danfa preferred visiting the mobile clinics to buying their condoms in a store. Nevertheless, as long as male family planning programs are tied to formal health services they will be limited by the clinics' mobility, by the cost of providing services through highly trained personnel, and by the stigma often attached with visiting a doctor. The greatest opportunity for increasing male use of birth control lies outside the clinic, in the community.

The distribution of free condoms by trained counselors is an effective way to involve men initially in family planning. But it is an expensive and time-consuming process. Most nations have scant resources for such efforts. Reaching a broad segment of the male population on a sustained basis requires the integration of condom distribution into commercial marketing networks. Even in the poorest parts of the world, most people shop at neighborhood stores or are visited daily by itinerant vendors. By using these commercial outlets to sell condoms at low subsidized prices--an approach known as social marketing--family planning programs have been able to increase contraceptive use and broaden male involvement in family planning. [See Development Digest, January 1979, pp. 29-57.]

In India and Sri Lanka, sites of the oldest social marketing programs, a visitor to even the smallest village is likely to see striking but tasteful advertisements for condoms on the doors of greengrocers and tea shops. Condoms are marketed with a flair previously reserved for selling soap or candy. Brightly colored packaging and catchy brand names seem to have spurred condom purchases. In India, sales grew from less than 25 million in the late sixties to 160 million in 1978/79. In Sri Lanka, condom sales leapt from about a half million in 1972 to nearly six million in 1978.

It is sobering to realize, however, that even these strikingly successful condom promotion programs have so far reached only a small portion of the men of reproductive age. Getting men to think positively about birth control and to put those attitudes into practice takes more than condom availability; it will ultimately rest on a more comprehensive change in male consciousness. Whether in Nigeria, China, or the United States, it is important to shape men's attitudes toward family planning when they are young.

Much of what men learn about their bodies, about sex and reproduction, about contraception, and about how to relate to women comes from discussions and interactions with friends, particularly as they are growing up. For generations, this learning process has perpetuated male stereotypes. Today, some family planning programs are attempting to use this powerful educational force to help men break out of old molds. In southern Nigeria, for example, the Lagos Family Health Clinic formed a Fathers' Club in 1974. The group meets one evening a month and is run by elected representatives of the members. It provides a forum for health education, helping men understand the link between family planning and the well-being of their wives and children. In any one year, about 20 percent of the fathers in the area attend a club meeting, enough to create a small group in the community that influences other men to be favorably disposed toward family planning.

In China, birth control has become the responsibility of small groups of men and women in factories, neighborhoods, and villages throughout the country. Following government guidelines, the groups decide on the number of children that should be born each year and then allocate the births to eligible couples. No longer can men force their wives into one pregnancy after another, to the detriment of the women's health. Self-criticism and peer pressure encourage men to consider the interests of their wives, their children, and their community when making family planning decisions. Although male birth control methods are so far not actively encouraged in most areas, this may begin to change when and if new and more attractive male contraceptive methods become more widely available and as taboos about vasectomy break down.

The involvement of men in family planning is certainly not new. India has had an official vasectomy program for two decades. What is new today is the realization on the part of some governments that a range of birth control services for men should be available. While particular experimental male projects may have varying degrees of success, this underlying commitment to greater male involvement in family planning suggests that one day men will have contraceptive and reproductive health programs comparable to those now provided for women.

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Prospects for Improved Contraception

Linda Atkinson, S. Bruce Schearer, Oscar Harkavy
and Richard Lincoln

[After a general review of the trends in global research on methods of contraception, this article describes four potential new methods which the authors consider significant, noting their advantages and drawbacks and the status of the research on them.]

Like most revolutions, the contraceptive revolution disappointed some whose expectations of it were unrealistically high. Two decades ago, when the oral contraceptive was brought to market and the IUD was reborn in antiseptic plastic and stainless steel, many scientists voiced optimism that that was only the beginning. It would not be long, we were told, before the perfect contraceptive would become available--highly effective, safe, acceptable, inexpensive and simple to administer and distribute. By now, it is generally recognized that there can never be such an ideal contraceptive, and that an array of methods is needed for people who live under different circumstances and have differing preferences and requirements. Each method has its advantages and drawbacks, and it is likely that there will always be some tradeoff between effectiveness and risk.

Granted all these qualifications, the distance from the scientist's imagination to the couple's bedroom has proved to be greater than some had believed. The array of vaccines, menses inducers, male pills and chemical sterilants first heralded a dozen or more years ago

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are for the most part still in early stages of development--for want of money, knowledge, manpower or all three. Not a single new contraceptive chemical entity has reached the marketplace since the introduction of the synthetic steroid norgestrel in 1968. The need for improved contraceptives has become more acute as the reputations of the pill and the IUD have been tarnished by an accumulation of medical reports indicating that they are not as safe as some had hoped, although not nearly as dangerous as some had feared. There have been a number of improvements in the safety or effectiveness of existing methods, but more basic innovations are needed.

Increasingly widespread utilization of the most effective modern methods of birth control associated with vigorous national family planning programs in a number of developing nations--including some very populous ones such as China, Indonesia, Mexico and Thailand--have helped bring down birthrates and explosive population growth rates dramatically. Although specific estimates differ, there is now general agreement that the rate of population growth in the developing world has been slowed, and that the trend toward further decline in growth rates is likely to continue. However, the very large number of unintended pregnancies and births that continue to occur in countries where all current methods, including abortion and sterilization, are widely available is evidence that today's methods are not sufficient to enable couples to realize their reproductive intentions even under very favorable circumstances, much less under conditions where storage, distribution and administration of contraceptives are problems.

Oral contraception, the IUD and sterilization are the cornerstones of current service delivery programs. The pill, although highly effective, is considered unsafe for older women who smoke or have other conditions (such as obesity or high blood pressure) that place them at high risk of cardiovascular disease. The advisability of the IUD, on the other hand, is questionable for young women who have not yet begun childbearing, because of the danger, however small, of infection that might compromise future fertility. Widely publicized information about health risks--sometimes sensationalized--has led a number of young women in developed countries to abandon the pill and the IUD. As family planning programs expand, pill and IUD use in developing countries continues to increase, but discontinuation of both methods is often relatively high; the first-year discontinuation rates in developing countries run as high as 20-40 percent of new pill and IUD users. And it is unlikely that the political and religious controversies over abortion will be settled in the foreseeable future. In a number of countries, especially in the Muslim world, it is probable that abortion will remain illegal for some time to come.

Under these circumstances, it seems unlikely that the present technological base for birth planning will be adequate to support the addition of 500-600 million more users over the next few decades. New reversible methods for men and women, as well as less intrusive and simpler means of sterilization, continue to be desperately needed in industrialized and in developing countries. What is the current state of contraceptive development, and what are the prospects for the future?

The Contraceptive R&D Process

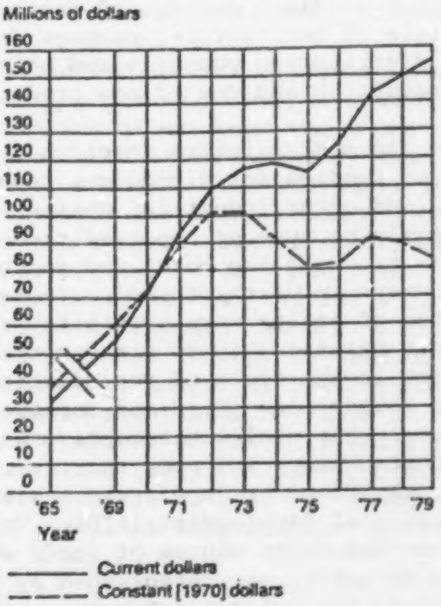
Producing and marketing a new contraceptive involve investment in six major types of activity: 1) the training of scientists to conduct research, and the support of those institutions that educate them; 2) basic scientific research in reproduction; 3) mission-oriented research; 4) applied research and development (R&D); 5) product introduction; and 6) evaluation of the effectiveness and safety of methods in use.

Basic research from a wide range of scientific disciplines is the source of fundamental knowledge needed to supply leads for development of contraceptive methods by improving knowledge about reproductive processes. Mission-oriented research generally refers to efforts aimed at accomplishing a specific contraceptive end; examples include a means of arresting spermatogenesis, or a luteolytic agent. The direct source of new products and technologies is applied R&D, which endeavors to utilize fundamental knowledge and understanding to develop new materials, new techniques and new processes in order to create a new product. Product introduction converts a newly developed prototype product into a widely available manufactured item. This final step comprises product acceptability and marketing studies, design and engineering of production plants, pilot trials of manufacture, package design, regulatory filings, establishment of distribution channels and other activities designed to ensure local introduction and use of new products.

Reproductive and contraceptive research did not benefit from the rapid expansion of funding for biomedical research by the governments of the United States and other industrial nations in the two decades after World War II, largely because of the traditional taboos against the study of sex and reproduction and the moral and religious controversies over government involvement in birth control. Indeed, until 1959, the U.S. National Institutes of Health were prohibited from supporting research having any explicit relationship to birth control. During the 1950s, biomedical research in the field of reproduction was largely funded by two major private foundations--Ford and Rockefeller--and a few individual philanthropists. The oral contraceptive was developed with the support of private philanthropy and some sectors of the pharmaceutical industry. In 1967, an Office of Population was established within the U.S. Agency for International Development (AID). The Center for Population Research (CPR), now the major source of funds worldwide for reproduction and contraceptive research, was established as part of the U.S. National Institute of Child Health and Human Development in 1968. In 1969, the United Nations Fund for Population Activities (UNFPA) began; recently, UNFPA has begun to make small expenditures for contraceptive development through annual contributions to the Human Reproduction Program of the World Health Organization (WHO). During the late 1960s, other developed countries--Britain, Canada, France, Sweden and West Germany--also began to fund reproductive and contraceptive research. Smaller efforts--most of them supported by international assistance agencies--were undertaken in some developing countries; the largest of these was in India.

The result of this increased concern can be seen in Figure 1. Funding for all aspects of reproductive and contraceptive research rose rapidly, from an estimated $31 million in 1965 to $117 million in 1973. Although this total research budget continued to climb in current dollars to an estimated $155 million in 1979, expenditures corrected for inflation had peaked in 1973. The U.S. government contributions for reproductive research have been increasing since the mid-1970s in constant as well as current dollars and represent nearly half the world total, while the investment of private philanthropies has declined somewhat and contributions of other governments apparently have not grown. The investment of the private pharmaceutical companies is believed to have plateaued in the late 1970s at about $14 million and apparently has declined in constant-dollar terms because of increased concern about the profitability of investment in research into new methods.

Figure 1. WORLDWIDE EXPENDITURES FOR REPRODUCTIVE RESEARCH 1965-1979



We will now discuss potential development of four contraceptive methods, any one of which, the authors believe, would significantly increase current use. Combined, the methods could revolutionize contraceptive practice in developing countries.

I. Nonsurgical Female Sterilization

Current efforts to develop a nonsurgical method of female tubal sterilization involve the delivery of a sclerosing agent to the uterotubal opening via the vaginal cervix and uterus. By irritating the tissue of the fallopian tube, the substance causes the lumen of the tube to close from scarring. Ideally, the method could be delivered by paramedical personnel trained to insert IUDs, and delivery could be accomplished without pain, using local anesthesia. Effectiveness should be as high as that experienced with current methods of surgical sterilization. These methods would need to be nontoxic. Sterilization would be irreversible.

Status of research. Two substances and various means of delivery are now under investigation. Methylcyanoacrylate and quinicrine hydrochloride are now being used in clinical trials. The former is a widely used "tissue glue" that polymerizes in the tube, forming a plug to which the tissue adheres. The plug eventually biodegrades, leaving behind scar tissue which permanently closes the tube.

Quinicrine is a drug that has been used for treatment of malaria. When placed in the uterine cavity in the form of crystalline pellets or in a thick suspension, the chemical enters the oviducts initiating a scarring process that results in tubal closure. A potentially more effective way of introducing the quinicrine into the tubal opening, by attaching pellets of the drug to the transverse arms or fundal portion of an IUD, is being tested. In this procedure, the pellets are held in place for several days, providing a longer time for the drug to penetrate the tubes.

Both of these sclerosing agents, and several instillation procedures, are being tested in small clinical trials. Long-term followup of subjects is necessary to observe the effective duration on closure as well as such possible problems as increased risk of ectopic pregnancy. At present, the methylcyanoacrylate seems to be only 80 percent effective in completely closing the tubes on just one application. It is believed that with two applications, an effectiveness rate of 95 percent could be achieved. Efforts are being made to improve delivery. Modifications of the instrument used for instillation are being investigated that would reduce its cost and improve its performance.

Advantages. A nonsurgical method would involve far less pain and discomfort than do sterilization methods now in use. The user would not require hospitalization nor the unavoidable long recovery period necessary with surgical methods. The risk of morbidity and mortality associated with general anesthesia (used with some current methods) and opening the abdomen to reach the fallopian tubes should be eliminated. The cost of nonsurgical sterilization should be lower than that of minilaparotomy, and much lower than that of laparoscopic sterilization. A major advantage of the method is the possibility that it could be delivered by paramedical personnel.

Drawbacks. It is possible that none of the agents currently under investigation will be capable of yielding effectiveness rates as high as those of surgical techniques because of incomplete closure or recanalization of the damaged section of the tube. This could mean that up to five percent of women who undergo the procedure would get pregnant. In addition, there may be rare complications associated with the chemicals used. Even the simplest approaches currently under study require operators with fairly high levels of technical skill and will probably require a clinic setting where sterile instruments are available.

II. A Reversible Method for Men

There are three approaches to male contraception: stopping the production of sperm; blocking the transport of sperm during intercourse; and affecting the quality of sperm so that they are incapable of fertilization. All male methods currently in use--vasectomy, the condom and withdrawal--are based on the second approach. What is being sought by contraceptive R&D organizations is a highly effective, reversible, self-administered, coitus-independent contraceptive that does not interfere with libido, is free from dangerous side effects, is inexpensive and is easy to distribute.

Status of research. It has long been known that massive doses of steroids will usually cause infertility in men by shutting down sperm production. Until recently, investigations into a possible male method have concentrated on different combinations of various steroidal hormones.

Another promising method for arresting spermatogenesis has recently entered early clinical trials: a chemical analog of the brain hormone--luteinizing hormone-releasing hormone (LHRH). The effects of this decapeptide, which stops sperm production in male rats, is being carefully observed in a small group of volunteer men. There has probably not been sufficient basic research to understand the effects of LHRH on the reproductive processes. If the analogs now in limited clinical trial prove successful, it will still be at least seven years and, if new analogs are needed, possibly 10-15 years, before they become generally available.

Another method under investigation that is apparently highly effective in stopping sperm production is gossypol, a derivative of cottonseed oil. Chinese scientists claim to have administered gossypol pills for at least six months to some 4,000 men, with an efficacy rate of 99 percent. Some of the men have been on the pills for more than six years. The pills are taken daily for about two months until sperm are no longer observed, and then are taken weekly to maintain infertility. Fertility generally returns to normal in about three months after discontinuation of treatment. Gossypol apparently works by incapacitating the sperm-producing cells.

Several research organizations outside China are investigating possible long-term adverse side effects. At least three to five years will be required for widespread human testing in other countries after current toxicology studies are completed. If side effects prove to be significant, a gossypol analog synthesis and screening program will be required to discover safe but effective compounds, and it would be 10-15 years before a marketable product would be generally available.

Little progress has been reported in finding an acceptable method which would cause infertility by inhibiting sperm maturation or motility. Important mission-oriented research remains to be done on sperm maturation and capacitation in order to make this type of research truly productive.

Some scientists are also intrigued with the potential of inhibin as a male contraceptive. If this naturally-occuring substance could be structurally identified and synthesized, it is thought, it could be effective in suppressing the secretion of follicle-stimulating hormone (FSH), necessary for normal spermatogenesis. However, considerable mission-oriented research would have to be undertaken before inhibin could be considered a potential male contraceptive.

Advantages. Based on clinical experience to date, it is thought that the LHRH analogs will have few systemic side effects. In addition to being effective as a contraceptive, gossypol should have little or no effect on libido, since it does not seem to affect the cells producing the male sex hormone, testosterone. The raw material is widely available, and the product should be relatively inexpensive. Neither LHRH nor gossypol would require clinical or surgical facilities, and both should be relatively easy to distribute.

Drawbacks. In addition to their contraceptive effect, the steroids reduce testosterone synthesis, sometimes resulting in loss of libido and development of female secondary sexual characteristics (such as enlarged breasts). The method is of unreliable effectiveness, as sperm counts are not reduced to zero in all men. In addition, testosterone has to be administered by injection at fairly frequent intervals, requiring clinical facilities; and recovery of fertility takes up to six months in some subjects.

LHRH analogs may decrease the synthesis of testosterone (and therefore libido). Both LHRH and gossypol would probably require one to two months of daily administration before they completely suppress sperm production. At present, the reversibility of the effects of these drugs on the testes is not well understood. Obviously, if there is permanent damage to the sperm-producing cells, neither product would be approved as a contraceptive. At any rate, it is likely that a very long recovery period would be required for any method that blocked sperm production.

Gossypol may well have some adverse side effect in humans since it is known to be highly toxic in some animal species.

III. An Antipregnancy Vaccine

Contraception could be achieved by vaccination with protein antigens specific to pregnancy or to an organ involved in the reproduction process. Circulating antibodies would interfere with ovulation, corpus luteum function, fertilization, early implantation, or maintainance of pregnancy, depending on the antigen selected. Ideally, the method would be administered in one injection. After a period of months required for the antibody titers to build up to sufficient levels, contraceptive effectiveness would be maintained for one to three years. Such an immunological method should be reversible with declining antibody titers, but effective contraception could be renewed by means of a single booster vaccination administered in the final months of the effective period.

Status of research. The principle of antibody reaction in response to an injection of a protein derived from the beta chain of human chorionic gonadotropin (hCG) has been shown in human clinical trials. However, the effectiveness of the antibodies and the safety of the method have not yet been demonstrated.

Two major approaches have been utilized: The first involved immunizations with an antigen consisting of highly purified beta-hCG chemically linked with tetanus toxoid. Menstruation and ovulation continued normally, but some pregnancies ensued. A more active antigen appears to be needed.

Theoretically, one problem with this approach is the possibility that cross-reactive antibodies could neutralize other similar pituitary hormones, stopping the function of the target organ permanently. Although no such cross-reactivity was found in experiments with women, some researchers have sought to protect against this possible problem; their work has constituted the second major approach to an antipregnancy vaccine. Those researchers have concentrated on finding a vaccine against a unique fragment of the beta-hCG chain which does not cross-react. However, the difficulty of finding a powerful enough adjuvant to create an effective antibody reaction is even greater when dealing with such a small fragment than when the whole beta-hCG molecule is the target.

Investigation at a much more basic level is also proceeding on antigens derived from the zona pellucida, the outer coating of the ovum at the time of ovulation and before implantation. Such antibodies are thought to form a deposit on the outer surface of the zona, which prevents sperm penetration and thus inhibits fertilization. Such antigens have not yet been isolated in pure form, however. Sperm antigens are also being studied, but so far they have proved relatively ineffective in animal tests. Given the very early stage of R&D in this area, a minimum of 10-15 years of sustained, high-priority effort will be needed to produce a vaccine using either the beta-hCG or one of the other approaches.

Advantages. Vaccination is a universally appreciated and understood medical intervention. The method is unlikely to require any special facilities for delivery, since in most countries there are already facilities for vaccination programs, and paramedical personnel and barefoot doctors are already trained to give injections. Effectiveness should be high, and the antifertility effect would be limited to one event in the reproductive process; short-term side effects should be minimal. The eventual cost would probably be similar to that for other types of vaccination offered by public-health programs in developing countries.

Drawbacks. Long intervals of effectiveness imply a relatively long time period for return to fertility, which might in itself reduce acceptability among some women. During the initial period--about three months--when antibody titers were being built up, and in the final months of declining titers, another method of contraception would be needed. Although paramedical personnel could administer the injections, they would have to be specially trained to deal with allergic reactions inevitable among a small percentage of recipients. What is more, a vaccination program requiring periodic inoculations is known to be difficult to mount and maintain in some developing-country settings.

IV. A Postpartum IUD

An intrauterine device that would be retained when it is inserted immediately after the placenta is delivered could reach all women who have assisted deliveries. Conventional IUDs inserted during the postpartum period are likely to be expelled about three times more often then when they are inserted during the menstrual cycle. The high rate of expulsion occurs because the postpartum uterus is in the process of contracting to its prepregnancy size. Unless the IUD can be anchored high in the uterine fundus, uterine contractions can easily displace it. Ideally, such a device would be effective over a woman's entire reproductive lifespan, and would need certainly to be effective without replacement for several years. Insertion by a specially trained non-physician birth attendant should be feasible. At least a 98-99 percent effectiveness rate should be obtained.

Status of research. Several types of postpartum devices are currently being investigated. One is simply a Lippes loop with three surgical sutures attached to the uppermost curve. The sutures anchor into the fundus of the uterus and slowly dissolve, so that by the time uterine involution is complete, the sutures have disappeared, and a conventional IUD remains in place. A second device, a modification of the Nova-T, a copper-bearing device, has plastic flanges near the base of the stem. If placed high in the fundus of the uterus, the flanges brace against the walls of the involuting uterus, preventing downward displacement. The first device has achieved encouragingly low expulsion rates in limited clinical trials. Field trials to determine effectiveness of both devices will be initiated shortly and if several conditions are met, a postpartum device could become widely available in less than five years.

Advantages. If a traditional birth attendant could be trained to insert such a device properly at the time of delivery, the method could reach large numbers of women in developing countries at a time when motivation to avoid pregnancy is generally high. Unlike the pill, IUDs do not interfere with lactation, and they do not introduce drugs or steroids into the breast milk. Many women in the developing world are not routinely seen by medical or paramedical personnel except when giving birth.

Drawbacks. The postpartum IUD would possess the same side effects associated with conventional devices--notably, disturbing menstrual bleeding patterns, pain and pelvic inflammatory disease and, possibly, subsequent infertility. Indeed, these devices may tend to increase postpartum bleeding, spotting and cramps, and special care would be needed to prevent infection. For women who deliver in hospitals, skilled medical services would presumably be available, but traditional birth assistants would need to have special training to insert these IUDs.

Other Possibilities

Scientists have long been interested in developing a pill, liquid, nasal spray or vaginal tampon that could be self-administered at the expected time of menses to induce menstruation and evacuation of the uterus. A desirable agent for this purpose would have few side effects and would totally evacuate the uterus. However, this possibility was excluded from consideration here as it is not strictly speaking a contraceptive method.

What Can Be Done?

The fact that world population growth rates have begun to slow in a number of countries of Asia and Latin America has led to complacency among some policy-makers that the "population problem" has been solved, and that no major initiatives, such as the development of a new contraceptive technology, are needed. Many of them have become convinced that the only solution lies in more efficient organization of services and the initiation of community pressures and incentives. However, the demonstration of receptivity to family planning efforts in countries around the world is a persuasive argument for assigning high priority to research in contraceptive development. There is no single "technological fix" for problems engendered by population growth. But new methods of fertility control that better meet individual needs and preferences and that are effective, safe and require less costly and sophisticated delivery systems than those now available can accelerate fertility declines now taking place, as well as help initiate them in places and among couples where current methods are inappropriate.

There is a good chance that some of the methods described here could be made available to the public within the next decade if public-sector funding for contraceptive development were increased by some four times, if donors made that funding available on a secure, long-term basis, if there were improved coordination and planning by donors and research programs, if there were more reasonable requirements by regulatory agencies and if there were more effective harnessing of the potential of industry. We are proposing a program of mission-oriented research involving the simultaneous pursuit of various technological leads to achieve a particular type of method (such as a male pill or an antipregnancy vaccine). This would certainly require--in addition to greatly increased funding--far greater coordination among developers and donors than now exists, in order to choose the methods for research concentration and to allocate the various approaches to those organizations that are best suited to pursue them. As funds become limited, this consideration becomes even more important.

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Signs of Change in Mortality Trends—Is Progress Slowing?

Davidson R. Gwatkin

[The extraordinarily fast rates of decrease in death rates in both developing and industrial countries after World War II have begun to show signs of slowing. The diversity among nations appears to be increasing. The evidence on changes is discussed, as are their possible causes and implications.]

Compared to the attention given fertility changes in the developing world, recent mortality trends have recieved little notice. Yet there are indications that developing world mortality patterns are also evolving in ways that are potentially important for human welfare. In particular, recent findings suggest that the remarkably rapid rates of mortality decline that have prevailed since World War II have begun to falter, to give way to a diverse, ambiguous situation marked by unexpected slowdowns in the pace of health improvements observed in many large areas of the developing world.

The Era of Rapid Mortality Decline

Widespread good health and low mortality are recent, principally twentieth century phenomena. In 1900, a typical newborn infant exposed through its lifetime to the conditions then existing in the world as a whole could expect to live some 30 years. Now, three-quarters of a century later, the prospect is for a lifespan approaching 60 years, almost twice as long. Leaving aside relatively limited periods of unusual disaster, life expectancy at birth has rarely been below 20 years. Thus, almost three-quarters of the total increase of longevity in recorded human history has been concentrated in the past 75 or 80 years. Until about 1960,

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the dominant trend was generally one of accelerating progress. This took the form of three waves, each reaching greater heights than that preceding it, culminating in extraordinarily rapid rates of improvement, especially in the world's poorest regions, during the period's later stages.

The first wave originated in Western Europe in the late 1800s and spread to the United States soon thereafter. Except for a pause during the interwar years, presumably resulting from the Great Depression, the rate of improvement in Western European life expectancy increased steadily from the late nineteenth century into the 1950s. From the virtual stagnation recorded between 1840 and 1850, the annual increase in life expectancy rose to 0.20 years and in 1880-90 and 0.40 years in 1910-20. [As an example of the average annual rate of increase: suppose life expectancy rises from 52 to 54 years in a period of six years. The increase is 2.0 years; the rate of increase per year is 2.0 ÷ 6 = 0.33 years.] Then, after a fall to 0.29 years during the 1930s, the period from 1940 to approximately 1955 saw an annual increment of 0.43 years. In the United States, the rate of life expectancy increase rose steadily from the turn of the century to 0.56 years annually during the 1920s, fell to 0.32 years annually in the 1930s, and then recovered to 0.53 years annually during the following decade.

Shortly after the acceleration of mortality decline in the West, the second wave of even more rapid progress began to be recorded in Eastern and Southern Europe. By the 1920s, life expectancy in the nine countries of that region for which data are available was rising by over 0.50 years annually. After a virtual cessation of progress in the late 1930s and early 1940s, the region registered a still more rapid average annual gain of over 1.0 years during the following decade, a pace notably faster than the most rapid rate of gain experienced in Western Europe or the United States. By the 1960s, Eastern and Southern Europe's rapid progress had nearly eliminated the traditional large differences between life expectancies there and in Northern and Western Europe.

The third wave, in the developing countries, appeared shortly after World War II. Such evidence as is available suggests that significant mortality decline had begun earlier in at least some areas: soon after the turn of the century in parts of Latin America, and during the 1920s in India, for example. But such increases were modest compared with those that came later, for soon after World War II annual gains in life expectancy averaging over a year were recorded for periods of up to a decade in such diverse places as Taiwan, Malaysia, Sri Lanka, Mauritius, Jamaica, and Mexico. In Mauritius and Sri Lanka, the increase exceeded two years annually: life expectancy rose from 33.0 to 51.5 years between 1943/46 and 1951/53 in Mauritius and from 42.7 years in 1946 to 56.7 years in 1953 in Sri Lanka. Many developing countries recorded life expectancy gains three or more times as large as those achieved in Western Europe at a comparable stage in its mortality transition.

As a result of such waves of acceleration, life expectancy appears to have been rising at a record or near-record pace in most parts of the world during the decade or so immediately following the end of World War II. By far the most impressive of the increases were those occurring in the developing countries. Not only were they clearly faster than in Europe and the United States, they were occurring in settings where life expectancies were 15 to 30 years below those in Europe and the United States. Such rapid progress coming at such low initial levels of life expectancy was, as many commentators noted, quite without precedent in history.

Also, unlike the rapid developed-country mortality declines, which were recognized as probably unsustainable, these developing world increases seemed likely to continue for some time into the future. Life expectancy in the advanced nations was already high by 1950, with most deaths occurring at older ages, caused by relatively intractable degenerative diseases; and as a result, the rapid life expectancy increases of the preceding century were widely considered to be unrepeatable. But the situation in the developing world was different: life expectancies were still low; the introduction of public health and disease control methods suggested that economic and social misery need no longer pose a significant barrier to sharp rises in survival probabilities; and the unprecedentedly rapid mortality gains in those leading developing countries with reliable data seemed to reinforce the sense that comparably rapid gains ought to be achievable in regions where mortality transitions were just beginning. Thus, while an eventual slowdown in the pace of mortality decline was recognized as inevitable, and while there was some concern about the longer range mortality implications of accelerating population growth, by and large the outlook for the years immediately ahead seemed promising. The authors of the comprehensive and authoritative 1962 United Nations report on mortality suggested that: "It may not be too much to hope that, within a decade or two, the vast majority of the world's peoples will have an expectation of life at birth of 65 years or more." In 1963, as shown in Table 1, the UN projections foresaw an increase in the pace of life expectancy improvement in the less developed regions from the 0.50 years recorded annually between 1960/65 and 1965/70 to 0.58 years annually between 1965/70 and 1970/75.

Signs of Slowing Progress and Increasing Diversity

As will soon become clear, data problems render very difficult any precise statement about what has recently been happening to mortality trends, especially in the developing world. But the figures

Table 1
Anticipated and Reported Rates of Life Expectancy Increase: Less Developed Regions, 1960/65–65/70 and 1965/70–70/75

	Average Annual Increase, 1960/65–65/70 (years)	Average Annual Increase, 1965/70–70/75 (years)
As anticipated in 1968[a]	0.50	0.58
As reported in 1978[b]	0.52	0.40

[a] Medium variant figures calculated from data presented in United Nations, Department of Economic and Social Affairs, *World Population Prospects as Assessed in 1968* (ST/SOA/Series A/53, "Population Studies, No. 53"; New York: United Nations, 1973), p. 141.

[b] Calculated from data presented in United Nations, Department of International Social and Economic Affairs, Population Division, *World Population Trends and Prospects by Country, 1950–2000: Summary Report of the 1978 Assessment* (ST/ESA/SER. R/33), 1979, p. 28. (Figures are arithmetic averages of male and female life expectancies.)

and analyses that exist are adequate to indicate rather clearly that the continuing accelerations in mortality decline that marked the period from 1900 to the mid-1960s have largely come to an end. They appear to have been succeeded by slower progress and increasing diversity, recorded both in those areas where slowdowns had been anticipated and also in many regions where rapid progress had been expected to continue.

Recent trends can be assessed with greatest confidence in the developed countries, where, as indicated, a deceleration had been expected. In the Western European countries referred to earlier, for example, life expectancy increased at around 0.11 years annually during the 1960s, down from the annual increase of 0.40-0.50 years of the late 1940s and early 1950s; the pace of improvement in the United States was 0.24 years annually between 1960 and 1970, less than half the 0.53-0.55 years annually of the earlier decades; the nine Eastern and Southern European countries advanced at an annual rate of 0.20 years, down from the previous pace of over one year annually.

Elsewhere, while progress has continued, the available estimates provide little basis for believing that the rapid post-World War II pace of developing world mortality decline was maintained, and they provide numerous indications of decelerating progress in many large areas and a resulting failure to achieve the life expectancy levels that had earlier seemed within reach. According to the most recent (1978) UN estimates, for example, only about 30 percent of the world's population--and only 2-3 percent of the population of the developing nations--lived in countries with an average life expectancy of 65 years or more, one decade after the 1962 statement cited. As Table 1 indicates, the earlier-anticipated acceleration in the average annual increase in the less developed regions from 0.50 to 0.58 years between 1960/65-1965/70 and 1965/70-1970/75 did not materialize. Instead, there was a slowing from 0.52 to 0.40 years. According to Table 2, life expectancy in both the more and the less developed regions was increasing by 0.6-0.7 years annually in the mid-1950s. By the early 1970s, the reported annual improvements were only around 0.15-0.20 years in the more developed countries, and 0.40 years in the less developed nations. While the figures represent no more than general orders of magnitude, it is notable that none of the three major regions of the developing world--Asia, Africa, and Latin America--recorded an increase in the rate of progress at any time later than the late 1950s or early 1960s. The dominant trend, rather, was a steady decline.

Table 2
Levels and Rates of Increase
in Life Expectancy by Major World Regions,
1950/55–1970/75

Life Expectancy at Birth (in years)

Region	1950/55	1955/60	1960/65	1965/70	1970/75
World	47.4	50.2	52.7	54.5	56.2
More Developed Regions	65.2	68.3	69.8	70.4	71.2
Less Developed Regions	42.6	45.8	48.8	51.4	53.4
Africa	37.6	39.8	42.2	44.5	46.5
Latin America	52.0	55.0	57.3	59.4	61.3
Asia	43.4	46.9	50.4	53.4	56.0

Average Annual Increase in Life Expectancy at Birth (in years)

Region	1950/55–1955/60	1955/60–1960/65	1960/65–1965/70	1965/70–1970/75
World	0.56	0.50	0.36	0.34
More Developed Regions	0.62	0.30	0.12	0.16
Less Developed Regions	0.64	0.60	0.52	0.40
Africa	0.44	0.48	0.46	0.40
Latin America	0.60	0.46	0.42	0.38
Asia	0.70	0.70	0.60	0.52

SOURCE: Calculated from data presented in United Nations, Department of International Social and Economic Affairs, Population Division, *World Population Trends and Prospects by Country, 1950–2000: Summary Report of the 1978 Assessment* (ST/ESA/SER. R/33), 1979, pp. 62-66. (Figures are arithmetic averages of male and female life expectancies. Asia life expectancies are the averages, weighted by population, of United Nations East and South Asia figures.)

These UN estimates also suggest a weakening in the tendency toward the convergence among the world's countries and regions that had earlier been a noteworthy feature of mortality trends. The life expectancy gap between the more and less developed regions of the world was reduced by only a little more than one year between 1965/70 and 1970/75, compared with two years during the preceding five-year period. More distinct is the absence of any tendency toward a reduction in the life expectancy gap between the less and more advanced nations within the world's developing regions during the past quarter-century, because laggard as well as advanced countries were affected by the slowed pace of progress.

[Note: A section omitted from this extract examines in detail population data from other sources for countries in the less developed regions. These figures generally show declines in the rates of increase in life expectancy comparable to those in the UN figures.]

Possible Causes

It seems fairly clear that other reports available for individual regions and countries point to changes in developing-world mortality trends at least as significant as those indicated by the UN estimates of Table 2. Equally clear, though, are the illustrations that such individual country and regional studies provide of the limited reliability of developing country mortality data and of the resulting problems that arise in attempting to assess developing country mortality trends on the basis of the available demographic data alone. No mortality data of even moderate reliability exist for China, the world's most populous country, or for Sub-Saharan Africa. In most cases, the information available consists principally of estimates by demographers applying their statistical skills and professional judgments to bits and pieces of information drawn from a wide variety of sources. It is clear, certainly, that estimates prepared in this way are much more than simply guesses drawn out of thin air; and one cannot dismiss as worthless the best demographic judgment available. But still, the fact remains that any discussion of developing world mortality levels and trends unavoidably deals more with professional judgment than with firm data.

In view of such uncertainties, it becomes particularly important to assess the plausibility of the figures reported in the demographic literature by comparing them with what is known about recent developments concerning factors thought to be responsible for mortality trends. On the whole, the evidence indicates that in light of what is known about recent medical, social, and economic progress, one might well anticipate slowdowns in the rapid mortality declines found earlier in the developing world.

Public health developments. A notable aspect of recent developments in public health and medical care programs has been what many authorities view as a marked decline in their capacity to deal with evolving disease problems of the developing world. In particular, the diarrhea, pneumonia, and malnutrition that now predominate in much of the developing world appear to be posing a significantly more difficult challenge to medical and health programs than the communicable diseases prominent in earlier years. This provides a basis for suspecting significant decrease in the contribution of medical and health programs to mortality decline.

Although the rapid mortality decreases had begun in some areas before the advent of effective medical approaches, the marked progress recorded during the years immediately following World War II appears to have owed a great deal to the new generation of improved medical technology that became available at that time. The postwar period is well known for the first widespread introduction in the West as well as the developing world of the modern antibiotics and insecticides whose development had been hastened to support World War II military operations, and the markedly improved drugs for the treatment of tuberculosis which first came into widespread use in the late 1940s. And it is possible to trace impressive accelerations in mortality decline in specific countries to the time when such new technologies became available.

In the advanced nations, examples that come readily to mind include the rapid fall in mortality concurrent with the introduction of antibiotics in the United States; the marked acceleration in the decline of mortality from tuberculosis in New Zealand, England and Wales, and New York City following the introduction of new drugs for treating tuberculosis in 1947; and the elimination of deaths caused by malaria in previously endemic Italy by the close of a 1945-58 insecticide-based drive. In the developing world, the examples are even more numerous, and the gains appear to have been at least equally great. On the basis of careful econometric investigation, Samuel Preston has concluded that factors other than social and economic development--notably health measures--could be credited with about one-half of the 18-year increase in developing world life expectancy between 1935-40 and 1965-70. While environmental improvements--such as increases in protected household water supplies and improved sanitary facilities--presumably played a role, gains against those infectious diseases most amenable to direct treatment or control through technological means were particularly significant. Malaria control alone, for example, has been associated with a five-to-six point fall in the Indian crude death rate and with almost a quarter of the improvement in Sri Lankan longevity. Smallpox is thought to have been eradicated; mortality from tuberculosis is now notably lower in the developing world than it was in the West when overall mortality levels were comparable; and, although the data are uncertain, there appears to have been significant progress against some other types of airborne respiratory infections as a result of the combined impact of antibiotic therapy and improved living standards.

As the number of deaths attributable to these diseases has declined, they have been replaced as leading causes of developing world mortality by by less specific gastrointestinal and respiratory infections that are much more difficult for standard Western medical technology to handle effectively. Infectious and parasitic diseases, Samuel Preston and Verne Nelson have shown, have made progressively smaller contributions to overall mortality levels, with diarrheal diseases rising (in relative terms) to replace them. As a result, they report, mortality from diarrhea in the developing world is typically twice to three times as high as it was in the West at a time when overall mortality levels were similar.

During the 1960s physician- and clinic-based medical services came increasingly to replace campaigns against the by then largely eliminated communicable diseases as the mainstays of developing country health programs. In the view of most observers these medical service units have thus far been unable to handle the newly dominant diseases effectively. For example, John Bryant's influential 1969 volume on health care in developing countries concluded:

> The great weapons of modern medicine are aimed at the pathophysiology of disease and its susceptivity to pharmaceutical, immunological, or surgical attack. Health services are designed to deliver these weapons mainly through the hands of doctors. The dismal fact is that the great killers of children--diarrhea, pneumonia, malnutrition--are beyond the reach of these weapons. If children sick with these diseases reach the physician, there are sharp limits to what he can do. Diarrhea and pneumonia are often not affected by antibiotics, and the frequent presence of malnutrition makes even supportive therapy difficult or futile. And even these interventions by the physician, whether or not they are therapeutically effective, are only sporadic ripples in a running tide of disease. We are speaking of societies in which, at any given time, a third of the children may have diarrhea and more than that may be malnourished. Their lives are saturated with the causes--poverty, crowding, ignorance, poor ventilation, filth, flies. (Health and the Developing World, Cornell University Press, 1969, p. 39.)

Social and Economic Trends. Inimical as such trends in the health sector obviously are for continued rapid mortality decline in the developing world, further rapid progress could nonetheless have taken place had there been an offsetting acceleration in the pace of social and economic progress. There is little indication, though, that any such acceleration has occurred. More prevalent are suggestions of increasing diversification and slowdowns within the developing world with respect to a number of aspects of social and economic progress generally considered most directly relevant for mortality decline.

The World Bank's *World Development Report* points to only a minor decrease from 3.1 percent to 2.9 percent in the annual growth of real per capita gross national product between 1960/70 and 1970/80 for 90 developing countries. But within this fairly steady pace of development, the records of different countries or groups of countries varied greatly. While the growth of per capita GNP in the middle-income developing countries of East Asia and the Pacific rose from 4.9 to 5.6 percent annually, that of the low-income oil-importing nations of Sub-Saharan Africa declined from 1.6 percent to 0.2 percent. During 1960-78, the economies of those 52 countries categorized as middle income by the World Bank grew at an average annual rate of 3.4 percent annually, twice the 1.7 percent of the 38 lower income countries; and the gap between the two increased, from US$500 to over $1,000.

With respect to other aspects of development that are relevant for mortality, the trend figures suggest the onset of overall decelerations sometime during the 1960s. Food production in the developing world as a whole, for example, rose by about 40 percent during the 1950s and per capita food production increased by 11-12 percent. In the following decade, food production increased somewhat more slowly, by about 30 percent, while per capita food production increased only about three percent with a more rapid population growth. The Fourth World Survey of the Food and Agriculture Organization of the UN found that in the developing countries "during the period 1970 to 1976 the growth rate of total food production slowed down to 2.7 percent and to only 0.3 percent on a per caput basis... Indeed, during the early 1970s, the per caput increase in the developing countries has shrunk to an insignificant level." While recent years appear to have seen at least some recovery, developing country per capita food production in 1978 was only about 3 percent higher than in 1970--only around 1 percent higher when China is excluded.

In addition to such developments of world relevance, there are several instances where severe local economic and political difficulties enhance the credibility of reports of the altered mortality trends in particular countries. Probably the most conspicuous example is the series of disasters that beset Bangladesh: the 1970 cyclone that devastated the country, the severe civil disorders associated with that country's transition to independence in 1971 and 1972, the unusually difficult agricultural years that followed immediately thereafter. In India there was a 5-7 percent decline in per capita calorie and protein availability between the early 1960s and the mid-1970s, along with the withering of the antimalaria campaign which had coincided with the particularly rapid mortality gains of the late 1950s and early 1960s (the reported number of malaria cases rose from 50,000 in 1961 to nearly 5 million by 1975). The years of stagnation or rises in mortality in Argentina and Uruguay were those that were marked by severe political and associated economic troubles. At the other end of the scale, unusually high levels of life expectancy achieved by such developing countries as Hong Kong, Taiwan, and Singapore do not seem as surprising as they otherwise might when it is recognized that all three were among the top four economic performers according to the World Bank.

Neither such impressions of individual countries nor what was said earlier about medical, social, and economic trends in the developing world as a whole are in themselves conclusive, of course. But even though only broadly suggestive, they are more than sufficient to provide reasonable support to the altered trends reported by recent mortality data. The slowdowns in progress against mortality would be logical concomitants of reduced power of existing medical technology and of slowed social progress. And similarly, increasing diversity in mortality patterns would seem natural in light of the widely different rates of economic and social progress being reported.

Approach of maximum longevity. It would be reasonable to expect some slowing of progress as life expectancy begins to approach a level of around 75 years, which, at the present state of human knowledge, lies close to a natural limit established by physiological degenerative processes. This is clearly relevant to trends in the developed countries, and also in a few situations like Hong Kong, Singapore, and Taiwan. But one cannot accept it as the principal explanation of changes observed elsewhere. This is because high-mortality countries as well as low-mortality countries seem to be experiencing a comparable slowing of progress. For example, Arriaga and Heligman found a sharp slowing not only in Venezuela, with a life expectancy of 63 years, but also in Guatemala and El Salvador, with life expectancies of 49 and 56 years; and the slowdowns in Asia have affected India and Bangladesh, where life expectancies have yet to reach 50 years, as well as Sri Lanka, with a life expectancy of over 60 years.

The End of an Era?

In brief, the mortality data available, supplemented by what is known about related medical, social, and economic trends, suggest that the era of unusually rapid developing country mortality declines has at least temporarily come to an end. Overall, progress continues, but at a slowing rate that, while still far from insignificant, had by the early 1970s reached a level more reminiscent of prewar Western Europe than of the developing world in the 1950s. While some countries have continued to record impressive gains, stagnating and even upward mortality trends are reported in others.

Whether such altered trends are harbingers of still less fortunate future developments remains to be seen. Perhaps the passage of time will reveal them to have been so, but other scenarios are certainly possible. Even under the worst possible legitimate interpretation of the imprecise data available, it is clear that the slowdowns have not thus far affected all of the developing world. The continuing rapid progress in a number of developed countries also suggests that early slowdowns are far from inevitable. At least some of the particularly severe setbacks discussed earlier appear due partly to conditions that are not likely to endure. Even slowdowns that may result from more fundamental decelerations in social, medical, and economic development are not necessarily immutable. The inappropriateness of conventional health care strategies has become increasingly recognized in recent years, and potentially promising alternative approaches are now under development. Food production poses a more formidable challenge, perhaps, but as numerous studies have shown, the potential for improving yields in the developing countries is very large. And so on. One cannot conclude from recent history that many or most developing world countries are inevitably doomed to Malthusian perdition. Yet neither would it be justified simply to shrug away the change reported as nothing more than statistical artifacts or temporary aberrations of no significance. Certainly, many of the figures cited are not beyond challenge: but there are too many of them, from too many sources, to be ignored. Taken together, they strongly suggest that the pace of health improvements has become more fragile and uncertain, as likely to slow or halt altoghether in response to unfortunate political, economic or climatic epidodes, as it is to continue along the seemingly automatic downward trajectory of the earlier part of the post-World War II period.

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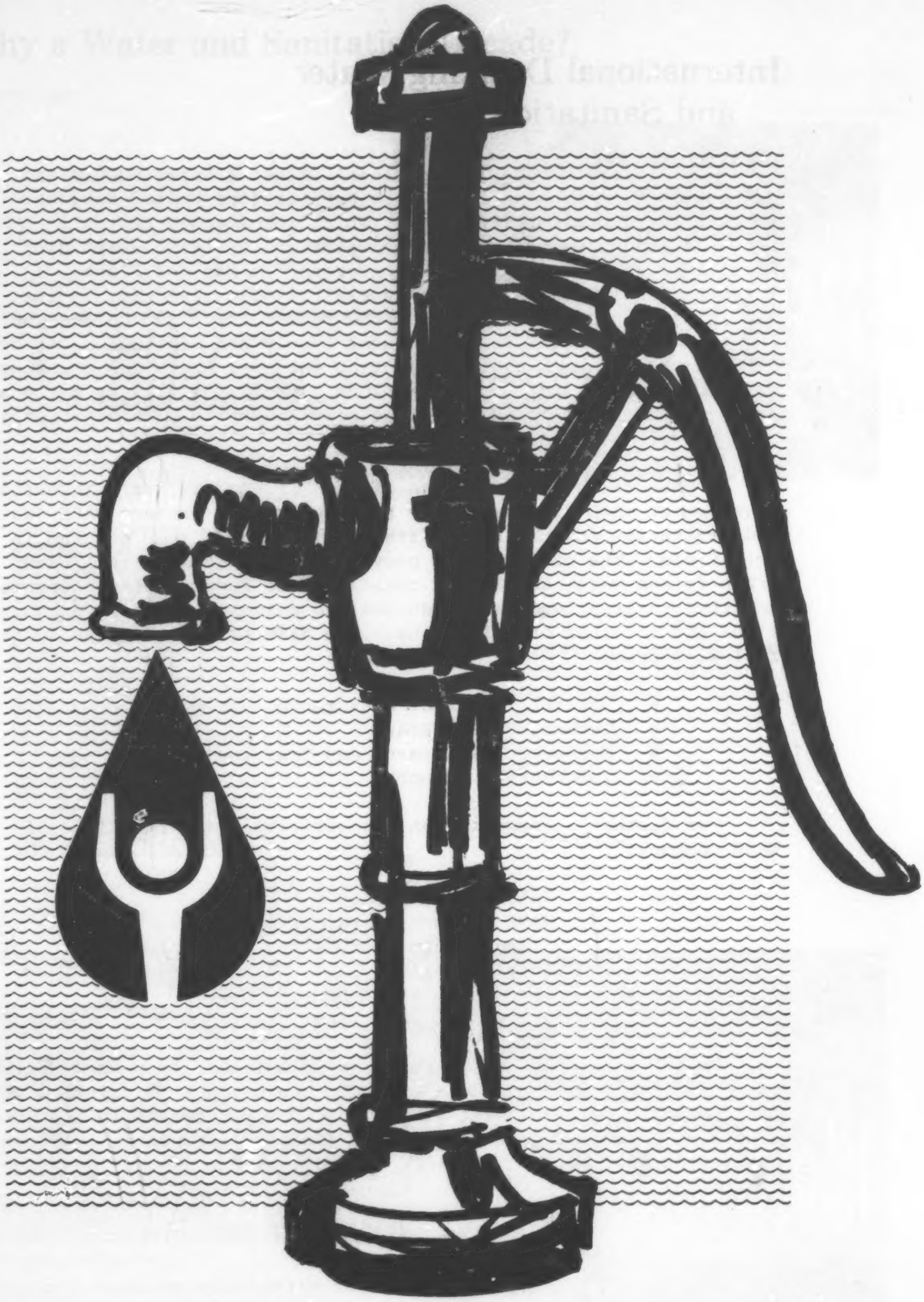


CLEAN WATER

International Drinking Water and Sanitation Decade

The history of the International Drinking Water Supply and Sanitation Decade began in 1976 at Habitat (the United Nations Conference on Human Settlements), which recommended that all people should have access to safe water and hygienic waste disposal by 1990. The U.N. Water Conference at Mar del Plata, Argentina in 1977 reaffirmed this Habitat objective and, in its Plan of Action, recommended that the period 1981-1990 be designated the International Drinking Water Supply and Sanitation Decade, devoted to promoting and implementing national plans for drinking water and sanitation. United Nations agencies as well as national and private aid agencies have made commitments to participation in the Decade's program.

A part of the contribution of the U.S. Agency for International Development (AID) to the Decade has been to add Project WASH (Water And Sanitation for Health) to its $200 million a year program in this field. The project will provide AID services in rural and urban-fringe water supply and sanitation to host country governments, to other international aid agencies, to private voluntary organizations and to other organizations. The WASH project assists in the following areas:

- General Technical Assistance
- Technology Transfer
- Manpower Development and Training
- Information Support

For further information on the activities and functions of WASH contact:

Information Director
WASH Project Coordination
and Information Center
Room 1002
1611 North Kent Street
Arlington, Va. 22209 USA

On the preceding page: The pump symbolizes the United Nations Water and Sanitation Decade's attempt to provide safe drinking water for the world by 1990. The U.N. symbol for the Decade is the water drop with a human figure inside it. (Graphics: Barbieri & Green, Washington, D.C.).

Why a Water and Sanitation Decade?

Earthscan

Dried-up riverbed/Lecho de rio seco/Cours d'eau a sec. Turkana. Kenya. Mohamed Amin/Earthscan

Mersa, Ethiopia. ICEF 7512. Bill Campbell/UNICEF

Madras, India. Mark Edwards

Presently, there is a great inadequacy in the quantity and/or quality of drinking water available to large portions of the population throughout the Third World.

Nepal. ICEF 7155. Nik Wheeler/UNICEF

Outskirts of Bogota/Barrio marginal de Bogota/Aux environs de Bogota. Colombia. Fetu Tisnes/Earthscan

Earthscan supplies information to the media on environment and development, London, England.

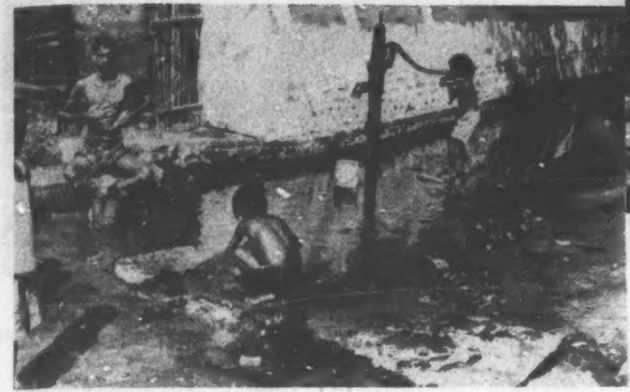
Throughout most of the Third World, fetching water is women's work. If the nearest tap or waterhole is miles away, this can mean heavy, backbreaking labor for several hours every day.

Republic of Korea. Mark Edwards

Rajasthan, India. Sanjay Acharya/Earthscan

Haiti. Mark Edwards

Mexico. Mark Edwards



Calcutta, India. 78/001/24. Dutt/UNICEF

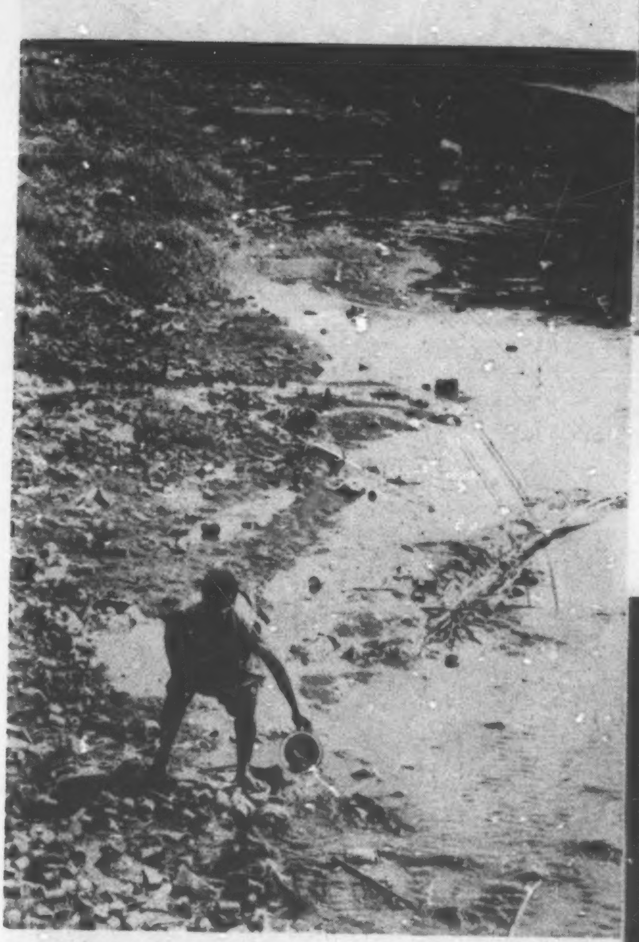
Haiti. Mark Edwards.

Rivers and pools used for drinking can be polluted by industry, agriculture, washing or bathing. Urban water pipes and pumps are often contaminated by sewage, especially when the pressure drops.

River Nile/Rio Nilo/Le Nil. Egypt. Mark Edwards.

Rice paddy water/Aqua de los arrozales/Eau des rizieres. Java, Indonesia. ICEF 7453 Watson/UNICEF

Rajasthan, India. Sanjay Acharya/Earthscan



Lagos, Nigeria. Mark Edwards

La Salada, Botota, Colombia. German Castro/Earthscan

Dirty or insufficient water kills. Diarrhea alone probably kills 25 million Third Worlders every year. But clean water, itself, cannot bring health in a dirty, unhealthy environment.

Lagos, Nigeria. Mark Edwards

Nepal. Mark Edwards

Republic of Korea. Mark Edwards

Like dirty water, inadequate sanitation causes disease. In too many developing countries, people still have to wash in drains contaminated with sewage. Safe latrines are essential for basic health.

Open sewer. Alcantarilla a cielo abierto. Egout a ciel ouvert. Calcutta, India. Mark Edwards

Lagos, Nigeria. Mark Edwards

New tap/Nuevo surtidor/Nouveau robinet. Malawi. ICEF 7480. Seitz/UNICEF

Sarawak, Malaysia. WHO 17117. A J Abcede/WHO

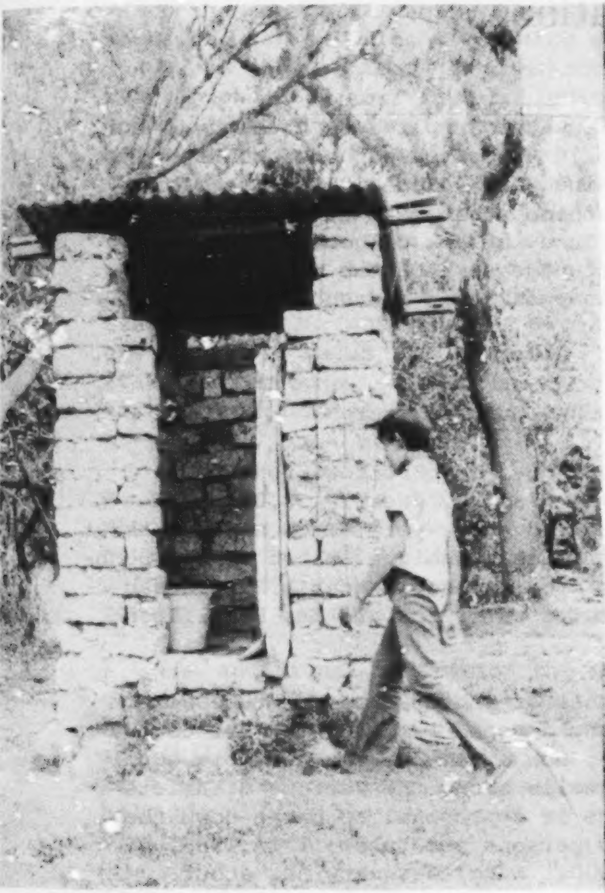
Improved water supplies have a marked positive effect upon the health of a population when combined with health, education and community involvement in the improvement activities.

Madras, India. Mark Edwards

Mexico. Mark Edwards

Urinals/Urinarios/Urinoirs. Calcutta, India. Mark Edwards

Improved sanitation facilities can reduce levels of morbidity and mortality caused by excreta-related disease. However, like improved supplies of water, sanitation must be considered just a part of an overall community improvement scheme if the maximum effects are to be felt.



Bucket latrine/Letrina de cubo/Seau d'aisance. Calcutta, India. Mark Edwards

New latrines and tap/Letrinas y surtidor nuevos/Nouveau robinet, nouvelles latrines. New Delhi, India Sanjay Acharya/Earthscan

[Photos and some captions from photosheets published by Earthscan, Copyright © Earthscan, London, 1980.]

READEX FICHE

Supplying Water: Maintenance Problems and Community Participation

Anil Agarwal

[Experience with projects to improve water supplies in both rural and urban areas throughout the Third World has revealed some problems that can and should be avoided in designing such schemes. The use of inappropriate technology, high cost schemes that make it harder to reach larger numbers of people, and a failure to seek or generate community support and participation in projects are some of the main problems. The following article illustrates some failures and successes in dealing with such problems.]

Water for Bangladesh: A Success Story

UNICEF is supporting a major effort to improve water facilities in Bangladesh. Nearly 50,000 tubewells are being installed every year, each serving about 180 people, using a simple technique suited to the country's subsoil. This program should enable Bangladesh to provide safe drinking water for all its 90 million people by 1985.

The average number of inhabitants per tubewell in Bangladesh had already dropped from 385 in 1971 to 162 in 1980, and there is now a much better and more equal distribution of tubewells among the various districts of Bangladesh. There is a proposal to bring down the average ratio to 120 persons per tubewell in 1985, 75 in 1990 and 70 by 2000. Bangladesh now has about 540,000 rural tubewells, and 70% of the rural population now has "reasonable access" to water within 150-200 meters, claims M. A. Hussain, chief engineer of the Department of Public Health Engineering. By 1985, the

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Department hopes to have 718,000 tubewells offering "reasonable access" to everyone. Initially, there were serious maintenance problems, but through simplification of the technology and efforts to involve the beneficiary communities, these have been largely solved.

Bangladesh has sand and silt down to great depths and a water table 5-6 meters (16-20 feet) below the surface almost everywhere. To reach the source of water, a cheap, simple and effective well-sinking technique is now being used which was developed in Calcutta in the 1940s. A 4-5 man team can construct a 30 meter (100 feet) deep tubewell in one 8-10 hour day, including the assembly of the hand pump. No drilling equipment is needed except galvanized iron pipes, a simple bamboo scaffold, and a chain wrench to tighten threaded joints. The iron pipe is simply screwed down into the ground. All the but top length is then replaced with polyvinyl chloride (PVC) tubing. The total cost of the pump and its installation is about US$100. UNICEF pays the cost of the pump and the PVC tubing, the government pays half the labor cost, and the community benefitting from the pump raises the rest--about $26 (400 takas). Where the daily wage rate of farm laborers is only 5 takas (33 US cents), even this investment means a big stake in the pump. UNICEF and Bangladeshi officials believe this initial contribution makes a great deal of difference to maintenance.

For each new pump, a beneficiary from the community is appointed as caretaker. He is provided with simple tools and spare parts for minor repairs, and he can call upon the services of one of the 100,000 government-trained "village mechanics" for major repairs. In this way, UNICEF hopes to reduce the percentage of pumps out of order at any moment from the current 20-25% to less than 10% in 1985.

An additional benefit of the water program is that jobs have been created in several foundries which are kept busy producing the 50,000 hand pumps needed each year. The four inch (10 centimeter) hand pump, specially designed for Bangladesh by UNICEF and manufactured locally from imported pig iron, is assembled in front of the pump caretaker to help him understand it better, as he will be responsible for supervising the maintenance.

Lessons from the Past

Capital investment in drinking water and sanitation facilities in the Third World was estimated at $6-7 billion in 1979. Most of it was spent on water supply programs. These projects have yielded a wealth of experience, but many of the lessons of the past have not yet been reflected in new schemes. Success stories like that of Bangladesh are rare. The often-depressing experiences will have to be taken carefully into account when planning for the U.N. World Water and Sanitation Decade (see page 66). Some of these are the following:

1. Water supply technology is often transferred without any serious consideration of its appropriateness to local conditions. This has led to serious maintenance problems.

2. Inappropriate technology--chiefly involving piped water or waterborne sewerage--often leads to high costs which rural villagers cannot afford, and which governments cannot afford to repeat very often. It is essential to reduce costs if entire populations are to be served.

3. Projects are often undertaken without any reference to what the community feels it needs. Little community participation is attempted, either in execution or maintenance.

4. Cumulative lack of maintenance may create needs as large as those of an unserved population. In many Third World cities, the main water pipes were laid down in colonial times--up

Peru WHO 16739 Paul Almasy/WHO

Figure 1

to 50 years ago--and have not been renewed since. Today they are overloaded, rusted and leaky--but the capital required for repairs, replacement and extensions is not available.

Hand Pumps: The Problem of Maintenance

Making sure that Third World rural water supply systems continue to work is just as important as constructing new ones. Unfortunately, both governments and aid agencies sometimes seem to forget this.

- A recent study by the Ross Institute of Tropical Hygiene in London estimates that about 30% of Third World rural water systems are currently out of order.

- A 1976 World Bank report stated that in some developing countries water supplies were failing at a more rapid rate than they were being constructed.

- At present, of nearly 450,000 hand-pump tubewells in Southeast Asia, 20-70% are broken.

- "Spot studies showed that nearly 70% of the pumps were not functioning at a given time" - a 1976 evaluation of the UNICEF/WHO-assisted rural water supplies program in India.

- "Approximately 75% of the hand pumps installed by the government program in the investigated wells were not in operation" - a 1976 investigation in Thailand.

- "Bangladesh has a better record for hand pump maintenance than many other countries." But at approximately 400,000 government-owned wells, 100,000 hand pumps are out of operation at any one time - a 1978 report prepared for the WHO International Reference Center on Community Water Supply (IRC) in The Hague.

Arnold Pacey of Oxfam, a British voluntary development agency, suggests that there are three approaches to the problem of hand pump technology and maintenance. In the first approach, the water planner tries to achieve total village self-reliance in the manufacture and maintenance of pumps. Ideally, a pump would be designed so that a village craftsman could make it himself, using simple tools and local materials. Clearly, he could then repair it whenever it went wrong. This approach should work well where the water table is high and pumps are less heavily used, and where a strong tradition of village craftsmanship already exists. Such conditions occur across wide areas of India, China and Southeast Asia. There is a wealth of traditional water supply technologies in the Third World, but these are generally neglected by engineers and planners, who tend to prefer "modern" technology, so this self-reliance approach is still rarely tried. A British technical adviser has tried to design a pump suitable for villagers to build in rural Ethiopia. The Family Farms project in southern Zambia has a workshop which also manufactures pumps for local use.

The second approach tries to achieve partial self-reliance. Hand pumps can be made in a specialized workshop in developing countries, but the local villagers will be able to maintain and repair them. There are several pumps of this type: the Craelius pump made in Kenya; the Wasp, Kirti and Kaveri pumps made in India; and "New No. 6" designed with the help of UNICEF and made in Bangladesh; and the Dempster model 23F made in the U.S.

In the third approach, the water planner asks for a Western-made pump which is as far as possible maintenance-free, eliminating village-level responsibility completely. This is what colonial administrations used to do, and is sometimes called the "black box" approach. Several decades ago, says Pacey, certain pumps were designed in Britain for use in the colonies, particularly for areas where normal maintenance could not be guaranteed. These were heavily built machines in which a handle attached to a large flywheel had to be turned in order to work the pump. Bearings and other mechanical parts were totally enclosed and protected from dirt and other interference. Such pumps worked successfully for long periods without maintenance, and many are still in use. Only a few of them are now being installed, because of their high cost. A more modern pump which can also operate for long periods without much maintenance is the hand-driven Monolift pump. Both the Monolift and flywheel pumps cost 6-10 times as much as simpler pumps which can do the same job but which do need maintenance.

Approach two, argues Pacey, is closest to the Oxfam philosophy. Its objective is "development," while the objective of approach three--still that of many governments--is "welfare." "Oxfam," he says, "has come to see water supply projects, along with others involving house-building, sanitation and other community-based activities, as being potential catalysts for social development." It is tempting, he wrote in 1976, to criticize UNICEF's pump policy in India as "purely concerned with supplying water on a relief or welfare basis with no component of social development." But he admits that Oxfam has also supported projects close to the welfare approach, with little or no community participation. And UNICEF has, in Bangladesh for example, supported the integration of water supply with community development.

Pacey's views on hand pump maintenance are not entirely accepted by UNICEF, which now strongly supports community participation, as its involvement with the Tamil Nadu pump doctor scheme indicates (see below).

Moreover, UNICEF, unlike Oxfam, must work through governments, most of which still see water as the business of only one ministry, usually public works, and having nothing to do with other ministries handling health, education, or rural development.

Community participation in Latin America. Figure 2
(Pan American Health Organization - Roger Hamilton)

Community Participation

Community participation is a buzz-word today. It is a rare international aid official who does not state that without community participation, drinking water and sanitation programs will fail. What does community participation mean? How can it be achieved? Few people seem to know the answers. But the relevance of community participation can be illustrated from experience.

A report from a typical small village in northeast Thailand illustrates some of the problems. An unique water filtration system was installed which was "a gem of appropriate technology," wrote Simon Watt, a British water engineer, in *New Scientist*. The system was constructed almost entirely from locally available materials. The filters were simple enough for the villagers to maintain without skilled supervision. They were cheap and could be easily copied by neighboring villages.

There were two filtering stages. The first used chopped coconut husks, to remove mud and other solids. The second was burnt rice husks, to remove color, taste and odor, and leave the filtered water clear. The coconut fibers and rice husks had to be changed every two to four months. This filter, developed by Richard Frankel of the Bangkok-based Asian Institute of Technology, did not reach the standards set by WHO. But it was a great improvement on no treatment at all, and offered one way of helping to reduce water-related diseases in rural villages.

The filter system was introduced in 1973, and accepted with enthusiasm. Three years later, it had been abandoned, as had a similar project in a neighboring village. What went wrong? The village headman had volunteered to act as the plant operator. The plant had been ceremonially opened with dignitaries and officials from many kilometers away. The water supply had cost each family about 8 baht (40 US cents) per month, mainly for fuel and repairs to the motor pump. In the first 18 months, however, the motor pump which raised the water up to the filter broke down seven times, and eventually it had to be replaced. When field assistants finally stopped visiting the village, the broken pump remained unrepaired. By July 1977, the motor pump had been removed, the water tanks were empty, and the villagers were back to their old water source: a polluted surface stream in which buffaloes and other animals bathed.

The headman frequently went away from the village for long periods, but because of the prestige which the scheme brought him, he was reluctant to delegate his responsibility. The lack of any local organization to maintain the filtration system, organize payment and collection of water rates, and teach the villagers the full benefits of a wholesome water supply, had rendered the project a miserable failure--despite the virtues of the project technology.

How should community participation be organized for a village water supply project? Arnold Pacey believes it should start long before any drilling or digging. He suggests that villagers should:

1. Formulate a request for help in installing their new water supply;

2. Discuss what sort of supply they need, and where they would like the well or other water points located;

3. Discuss their own contributions, which as well as cash should usually include some physical contribution such as clearing the site before the drilling rig comes;

4. Decide which members of the village should take up any special responsibilities: who should collect the cash, who should organize the work gangs, and who should be in charge of the pump when it is installed.

"If these four steps can be carried through under village leadership," says Pacey, "the drilling rigs and their crews are immediately placed in a less dominant position. They now wait for the villagers to request the well, and then cooperate with them in siting it and in construction... If a project is begun in this way and followed through in the same spirit with full participation by the villagers, many of the problems encountered in well/pump schemes will not crop up at all."

India: The Barefoot Hand-Pump Doctor

> "Providing pure drinking water to thirsty villages is not something engineers can achieve alone. The challenge is to make the people learn that the trouble-free operation of a pump is not so much the government's responsibility as their own. Tirunelveli is a small but sure sign that--given the right approach--the challenge can be met." So claims the staff of UNICEF's south central Asian regional office based in New Delhi.

Tirunelveli, a district in Tamil Nadu state near the southern tip of India, suffered a severe drought in 1975. A crash program was launched to provide drinking water to 11 badly hit districts. The sturdy Sholapur-type pump was used. But in the absence of maintenance support the breakdown rate was about 80%.

In 1976, the Tamil Nadu state government and UNICEF launched a scheme to train "barefoot hand pump doctors," chosen by the villagers. First, rural development officials visit each village and explain the importance of clean water and the role of villagers in maintaining the supply. A village meeting is then held where the village hand pump doctor is chosen. Often he is the local blacksmith or handyman: someone known to have some familiarity with machines.

The training of a group of hand pump doctors lasts two days, during which they are taught the anatomy of the pump, the diagnosis of common pump ailments, and the simplest rules for coping with drainage problems. The trainees take turns at a microscope, to look at the otherwise invisible germs in clear water and get an idea of the relationship between water and disease. Each pump doctor learns about the importance of drainage, and how to make a soak-pit. He learns about malaria, and how mosquitoes breed in puddles of water. He is taught the importance of using clean containers for storing water, so that the clean water from the pump remains so. Equipped with this knowledge and kit of tools, he returns to his village to become the voluntary (unpaid) caretaker of the pump. In the Tirunelveli experiment, government-paid "gram sevaks" (village-level workers) were also trained so that there would be a standby caretaker for every pump as well.

Training "handpump doctors"/Entrenando a los "medicos de bombas"/Cours d'instruction pour les "medecins des pompes". 76/042/54. Ken Forman/UNICEF

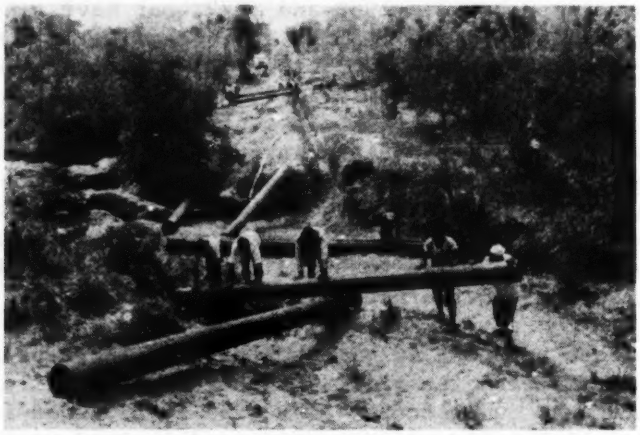
Figure 3

The duties of the hand pump doctor involve more prevention than cure. It is his task to wean the villagers away from using water from unprotected sources. He must teach them to understand the importance of water storage, and not to dirty the surroundings of the pump. The basic message during the training is formulated as a challenge to the villagers: "Drink clean water for a year and see the difference in your health."

On the pump itself, the main job of the hand pump doctor is preventive maintenance. He does a weekly check-up on the pump, and examines all the external nuts and bolts and working parts. If something is loose, shaky, or crooked, he knows enough to repair the pump. But if something else is wrong, he uses a prestamped reporting card to summon expert help.

The village hand pump doctor stands at the bottom of a three-tier maintenance system. The uppermost tier is at the District level: a mobile repair team (a junior engineer, mechanic and helper) equipped with a vehicle and a driver. The second-tier is at the Block level, the basic unit of rural administration in India, covering some tens of villages: an inspector-mechanic, whose responsibility is to visit and inspect all the 100 or so hand pumps in his charge. The village-level caretaker is the pivot for not only this rural water supply pyramid, but also for rural health. Since the very first month of the initial training course, the inspector-mechanics of Tirunelveli's 31 development blocks have had a steady inflow of reporting cards.

The Tamil Nadu Water Supply and Drainage Board was so impressed by the results of the experiment that within a few months it issued orders for the three-tier system to be introduced all over the state. It is now gradually being introduced to other states of India as well.



75 Sudan. ICEF 8478. Arila Vollan/UNICEF

Figure 4

Community Participation in Malawi

Malawi is one of the very few countries which is almost certain to meet the "Clean Water for All" target for its rural population by 1990--probably even before that date. To achieve this target, Malawi has only to step up its current water supply program by 13% a year. This achievement would be remarkable considering that Malawi is one of the poorest developing countries in the world. Ninety percent of its 5.2 million population live in rural areas, working largely on subsistence agriculture. Although those who live near Lake Malawi have easy access to water, most of the others have to walk long distances. The key to success has been community participation.

The first approach to water supply in Malawi was to get government and private agencies to dig deep boreholes (120-150 feet; 37-46 meters) equipped with hand pumps. By the end of 1977, about 4,000 such boreholes were spread across the country, and were being adequately maintained by 20 special teams. The cost was enormous. Each borehole served about 130 people and cost about $4,000, about $30 per capita, plus about $70 a year to maintain it.

About eight years ago, a government study suggested how to serve about 75% of the rural population at a fraction of this cost--providing the villagers were prepared to work for their water supply. In other areas, because of geological conditions, boreholes still remained the only solution. A large proportion of the villages use gravity water supplies. Water comes from perennial streams, above the level of cultivation to avoid contamination, and is piped into settling tanks and then directly down to the villages. The major cost is in digging miles of trenches for the pipes. Funds for materials, transport, surveyors and skilled workers to build the settling tanks, are provided by the government. Unskilled labor is provided by the villagers. Construction costs (excluding unskilled labor) per person served averaged only $4 per capita for schemes completed between 1969 and 1977, but have since risen to $6 because of inflation. By 1977, about 1,800 taps were in operation, and 750 miles of pipes had been laid by the villagers.

The Ministry of Community Development and Social Welfare (MCDSW) does not undertake a project unless invited by the District Development Committee (DDC), which consists of members of parliament, traditional authorities and local leaders of the ruling Malawi Congress Party. Once the DDC makes a request, the MCDSW draws up the designs, and the village leaders establish a committee to organize construction, which is shared among the villages using the scheme.

Some villages have dug 20 miles of trench. Work usually starts in February and March after the rains. Women, men and children all join in, bringing their own digging tools. The pipe is produced in Malawi from imported polyvinyl chloride powder (PVC) and is laid by the villagers. The site for each village tap is chosen by the villagers, who also construct a concrete apron around it and a concrete drain into a soakway. At the inauguration ceremony, villagers are told how to operate the tap and the costs they will have to bear if it is broken. The gravity schemes are maintained by village volunteers, after a two-week government training course.

About a million Malawians live in low-lying areas with high water tables. Shallow wells, up to 30 feet (9 meters) deep, are easily dug, but their mud walls crumble, animals use them, and their water becomes contaminated. Initially, the MCDSW tried to protect these wells by making a brick or concrete wall and a raised lip for the well. Labor was provided by the villagers and material costs borne by the government. But the villagers did not see any great advantage in these protected wells. Children often could not haul up the heavy bucket. Water could still be contaminated by dirty buckets. Progress was slow.

The MCDSW then developed a simple pump that can be made from local materials. It costs only $25-30, compared to the $700-1,000 required for the pumps used on deep wells. This pump is bolted to a concrete lid which encloses the entire well, and it can be operated by children. In 1978, the government undertook to build about 5,000 protected shallow wells, each serving about 100 people.

As with gravity schemes, self-help is playing a major role. The MCDSW provides cement for construction, a concrete slab and all the parts for assembling the pump. The local village committees provide transport by ox-cart for these materials, and all bricks, sand and labor required to construct the well. The materials cost to the government is less than $100 per well: less than $1 per person served. The Malawi government estimates that 30-50% of the rural population will ultimately be served by gravity systems, 25-35% by shallow wells and 25-35% by boreholes.

"The motivation of villagers to carry out self-help schemes," says Julian Bharier, a World Bank expert, "is closely linked to their recognition of the health benefits to be obtained." Most Malawians are illiterate, yet adequate sanitation is important to most people, as the large number of pit latrines in rural villages in Malawi indicates. Since the 1973-74 cholera epidemic, when villages with access to safe water were scarcely affected, the number of cases of diseases associated with water supply and sanitation has declined each year, illustrating the power of example in that nation. It is hoped that this case might also encourage safe water supply development elsewhere in the world.

[Extracted from Water and Sanitation for All? Earthscan Press Briefing Document No. 22, 1980, pp. 37-47. Copyright© Earthscan, London, England.]

Sanitation and Well Building

S. B. Watt and W. E. Wood

[Clean drinking and washing water can greatly reduce or eliminate a number of widespread diseases. However, new and improved wells must be kept free of contamination if they are to accomplish this purpose. The following article describes ways in which improved water facilities can be protected from contamination.]

Many of the diseases that cause illness and death to mankind are 'water related' in one way or another. They can be listed under various heads, e.g.:

(a) Water-borne diseases--those that may be carried in water and infect consumers. Cholera, dysentery, typhoid and hepatitis are of this class.

(b) Water-based diseases, where the organism causing the sickness spends part of its life cycle in an aquatic host, for example guinea worms or schistosomes.

(c) Water-shortage diseases, or diseases of dirt --those whose incidence could be reduced if ample water were available for washing and hygiene. Scabies, tropical ulcers, trachoma and infantile diarrhea are examples.

(d) Water-associated diseases, spread by insects that breed in water. Malaria, river blindness and sleeping sickness come under this heading. The mosquito, simulium fly or other causative agent is described as a 'water-related insect vector.'

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The first two of these classes can be drastically reduced by providing water that is free from infection. The third class will become less prevalent if sufficient water is available for personal washing and domestic hygiene, so the construction of wells giving ample supplies of safe water will serve to protect the public from all three. The fourth class of diseases will not be directly affected by well construction, but there may be an indirect effect if villagers no longer have to frequent swamps or other infested spots to collect their water. For example, schistosomiasis can be reduced if women and children do not have to enter infested water to collect their domestic supplies or to wash clothes. However, these remarks apply only to a hygienic well--one that has been designed and constructed in such a way as to protect the water it contains from contamination, and that is used and maintained in a hygienic manner. If these conditions are not fulfilled, the well, instead of being a factor of community health improvement, may actually become a means of spreading those very diseases that it was designed to prevent.

Hygiene education is essential if the full benefits of any water supply improvement scheme are to be realized. Well-users must understand the risks of contaminated water and the need for safe waste disposal in order to appreciate the necessity for protecting the supply.

Most water-related diseases are spread by wastes from an infected or ill person transmitted to the water supply in some way. Man is the main reservoir of most of the diseases that make him sick, and all water supply improvement schemes should be supplemented by sanitary measures that cut the cycle of disease by the efficient disposal of human wastes. These should include the protection of the water supply from contamination and, where appropriate, the treatment of the water to destroy any disease-causing bacteria, viruses or parasites before it is used.

Prevention of Contamination of a Well

There are three routes by which the water in a well may become contaminated: through the wellhead (see Fig. 1), through the lining, or through the water entering the intake.

An open well without a wellhead is always potentially dangerous. The ground around it becomes worn and slopes towards the shaft, allowing rain and spillage to wash into the well. In addition, in areas where guinea worm is endemic, the eggs of this parasite are carried into the water below to transmit the disease to a subsequent user. Hookworm and other infections can flourish in the soil immediately around the shaft, to be picked up by the bare feet of the villagers. If people are allowed to enter the well, to use unsanitary buckets to raise their water, to defecate or to wash themselves or their clothes in the vicinity, or if animals are permitted to approach the open well mouth, a whole new range of disease-spreading contamination may pollute the well.

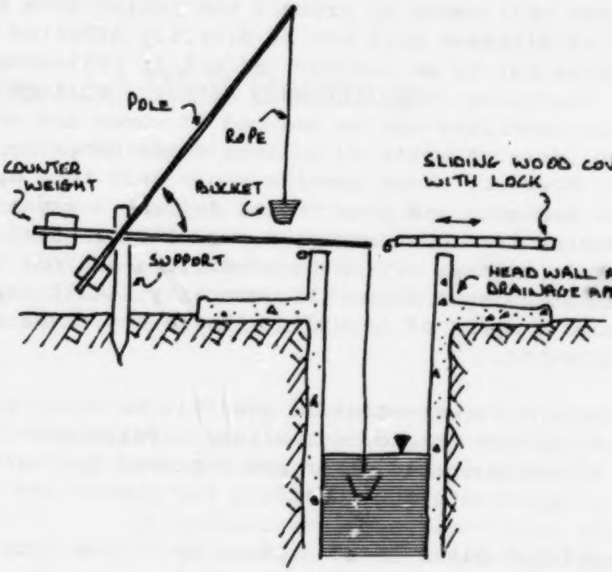


Figure 1. Domestic water supply. Brick-lined shallow hand dug well with headwell and drainage apron. Water is lifted out by bucket 'Shaduf' device made from bamboo. The bucket remains suspended above ground between periods of use. A sliding wooden cover which is locked by the well owner prevents rubbish from being thrown into the well. Thailand.

A properly designed wellhead can exclude most of these hazards. Two features are essential: a curb or headwall rising sufficiently high above the ground surface to prevent anything from washing or blowing into the well mouth, and narrow enough to discourage users from standing on it, and an impervious apron 2m wide, sloping away from the shaft in all directions. Around the outer edge of the apron there should be a raised rim to prevent spillage or waste water from running over the edge of the apron into the ground around the well. This rim collects the water for release into a pipe or impervious channel which carries it to a "soakaway pit" a safe distance away. (See Figure 2.)

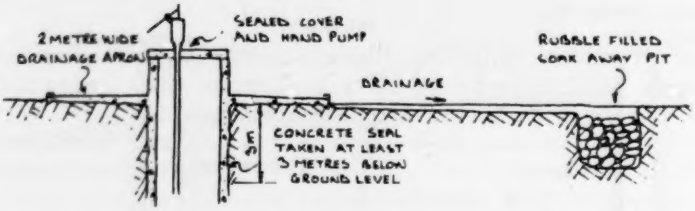


Figure 2. Prevention of wellhead pollution.

For complete safety a raised sealed cover is needed, but such a cover is most practical where a pump is fitted into it, as in Fig. 2. Where the well is to be left open for ropes and buckets to be used to draw the water, precautions must be taken to minimize the hazards of contamination. A moveable cover may be provided to protect the shaft from wind-blown dust, insects and the like when the well is not in use.

Pollution may enter through the shaft lining if this is not watertight. When a well is sunk through material such as sandstone, hard laterite or other rock, the walls of the shaft may be sufficiently strong to stand without support, and in such cases lining is often omitted. However, the top 3 meters at least should always be made waterproof by lining to prevent seepage from the surface soil layers, which are the most likely to carry dangerous contaminants. When a well is lined with material other than concrete, e.g. brickwork, masonry or similar substitute, particular care must be given to ensuring the water tightness of the top 3 meters and its junction with the wellhead.

The water in the aquifer may become polluted before it reaches the intake. A source of pollution, such as a pit privy or animal pen, will produce contaminated water that will soak downwards into the soil. Usually the polluted drainage will become filtered and purified within a short distance as it travels downward, but if the water table is too close to the surface, purification may be incomplete before the water enters the intake. A well should therefore be located as far away from potential sources of pollution as possible, certainly no nearer than 50m, and at a higher level of the water table. (See Fig. 3 and 4.) Obviously the more densely populated the area the more difficult this will be to achieve. It may be possible to arrange the privies in the immediate vicintiy to be cleared before well construction starts, but the saturated ground around them may remain hazardous for a long time after their use has been stopped.

One further potential hazard may render the water in a well unpleasant or impossible to drink--a concentration of salts dissolved from the soil by the groundwater in its passage to or within the aquifer. Some of these (e.g. chlorides, sulphates) make the water bitter or un-

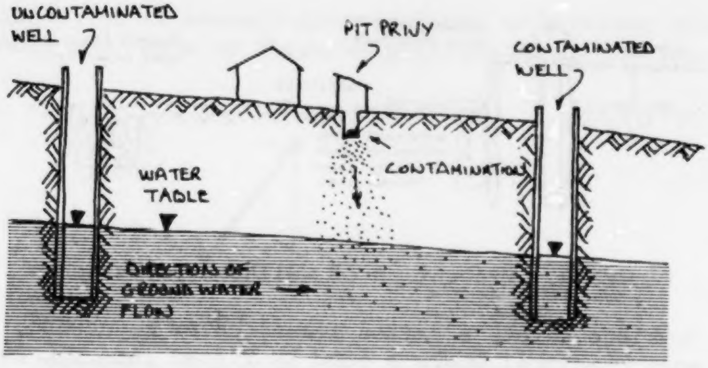

UNCONTAMINATED WELL
PIT PRIVY
CONTAMINATED WELL
CONTAMINATION
WATER TABLE
DIRECTION OF GROUND WATER FLOW

Figure 3. Contaminated wastes from pit privy soaking down to the aquifer and into the well.

palatable, some may be dangerous in excessive concentrations (e.g. heavy metals, nitrates), some constitute a nuisance only (e.g. iron salts that stain clothes washed in the water). All are difficult and expensive to remove. If there is any doubt a sample of the water should be sent for chemical analysis before a well is opened for public use. Salt concentrations in the ground usually occur over a fairly wide area, and evidence of their presence in nearby wells should always lead to suspicion that any new well may produce water that is not safely potable.

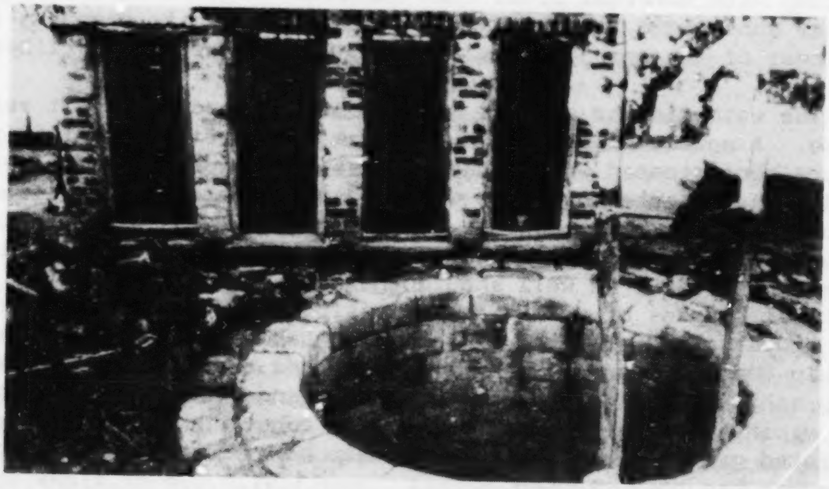


Figure 4. Wellhead Contamination--New latrines were built alongside a well, which will now have to be abandoned. Even if the well is filled in, the aquifer is still liable to be contaminated. India.

There are certain other precautions that can be taken by the village authorities. If animals are to be watered this should be done (preferably from properly constructed troughs) some way from the wells, and the wellhead should be fenced to keep animal droppings and the beasts themselves clear of the apron. Washing facilities for people and for their clothes should be far enough away to avoid the drainage seeping back into the ground around the wellhead.

Disinfection and Maintenance

Upon completion a new well should be properly disinfected before use, since it may have been contaminated by the well diggers themselves. Disinfection can be accomplished in numerous ways. One effective means is to lower a sealed but porous pot containing chloride of lime into the well. Such a pot can give protection for two or three weeks without the concentration of chlorine in the water ever rising to an unpalatable level. Health risks can be reduced by simple hygienic precautions during construction; above all, defecation within the immediate vicinity of the well must be forbidden.

Arrangements must be made for a well's future maintenance and hygienic use before it is used. Good maintenance depends on the designation of a person responsible for keeping the structure in good order. Hygienic use can only be achieved if well-users know how careless use of the well can contaminate the water and how this unsafe water can affect their health and that of their neighbors. Community support must be won; experience has shown that persuasion can achieve results that regulations cannot. Community participation in construction and maintenance is evidence of strong community support and concern.

Where the well is an open one, periodic cleaning should be arranged. In some parts of the world this is made into a special occasion at the time of the lowest water level, with the villagers cooperating in drawing the water in the well to the lowest level possible, while one or two men are lowered into the shaft to remove any accumulation of rubbish, sediment or vegetable growth. After such cleaning the well should again be disinfected before being put back into use.

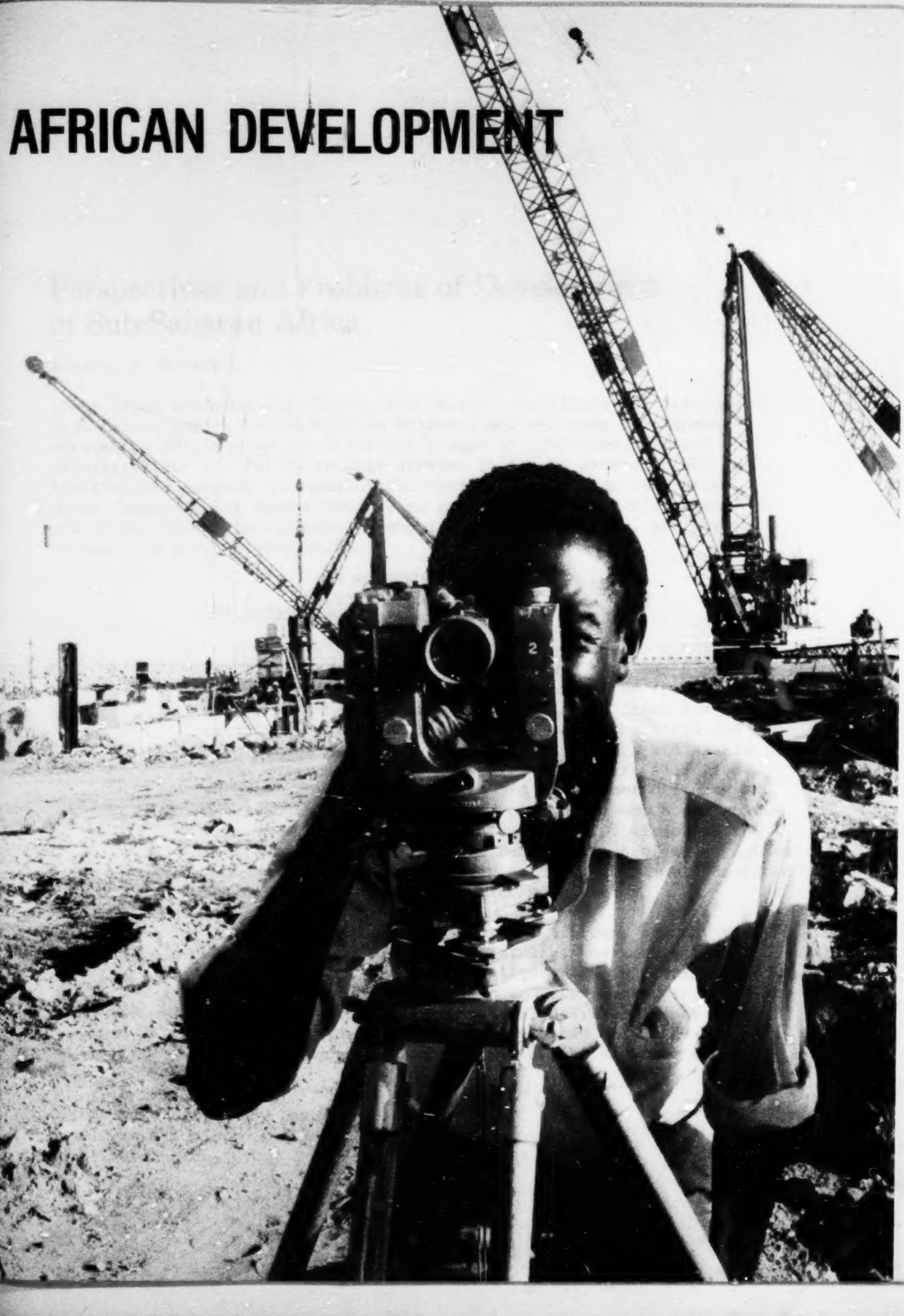
Hygienic usage is made easier if the wellhead is designed with this in mind. If a pump is fitted this is easier to achieve, though an important point to watch is that the pump be self-priming or that there be a tank for priming water--contamination can start from dirty water used to prime a hand pump. Where the well is an open one a potential source of pollution is the use of ropes and buckets. This can be minimized if communal ones are provided, so fixed to the wellhead that they cannot be removed, thrown on to the ground, or stored in an unsanitary manner. In places where it is customary and unavoidable for villagers to have their own ropes and buckets, these items should be hung up clear of rats and domestic animals when out of use, and not deposited on bare ground near the wellhead before and after they are used for drawing water. Further, it should be made the responsibility of a particular individual to see that the surroundings of the well are kept clean and in good repair. The apron should be swept; cracks in the concrete should be repaired; the area should be drained and the pump kept in good working order.

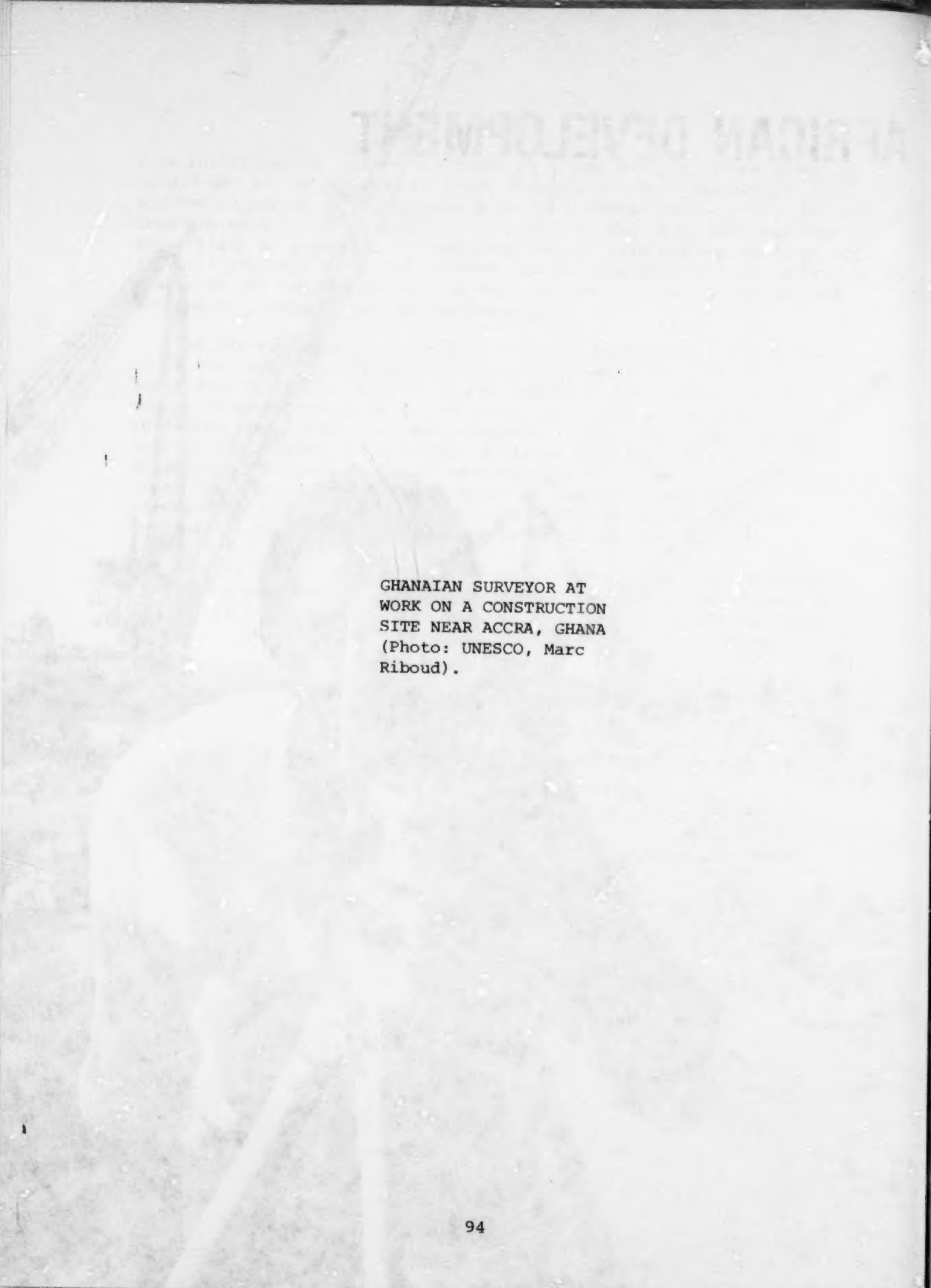
At the same time it is a good thing for health officials to explain the importance of protecting domestic water after it has been taken from the well. Disease can be spread within a family through water stored in open pots in the home, especially if these are not protected from domestic animals, rodents or insects. Precautions against the breeding of mosquito larvae in domestic water pots are especially necessary in areas where malaria or yellow fever are prevalent. Filariasis may be spread where spillage or waste water is allowed to collect into pools, and the resulting infection is not confined to the household where the nuisance occurs.

A final point concerns special precautions to be taken whenever there is a particular health hazard such as an epidemic of cholera or typhoid in the neighborhood. In cases like this it is wise to add a mild but continuous dose of disinfectant to the water in the well.

[Extracted from Chapter 2, Hand Dug Wells and Their Construction. Copyright© 1979, Intermediate Technology Publications Ltd., London.]

AFRICAN DEVELOPMENT





GHANAIAN SURVEYOR AT WORK ON A CONSTRUCTION SITE NEAR ACCRA, GHANA (Photo: UNESCO, Marc Riboud).

Perspectives and Problems of Development in Sub-Saharan Africa

Shankar N. Acharya

[This paper analyses the history and initial conditions for development facing post-colonial African nations, and outlines development strategies followed by two different groups of countries. Policy priorities for the future include greater research, extension and infrastructure support for smallholder agriculture, a more realistic urban formal sector wage structure to reduce rural-urban migration and foster more internationally competitive manufacturing, and more emphasis on savings generation.]

The Historical Legacy

The pre-colonial setting. The research findings of the Leakey family and others indicate that man's origins may be found in East Africa. But after the species had spread to other continents, Sub-Saharan Africa was increasingly isolated from land masses to the north and east by the spread of deserts across Sahara and Arabia. These deserts, and the non-navigability of major rivers, reduced the contacts of Africans with other cultures and deprived them of the mingling of peoples which can stimulate civilization. The 15th century A.D. witnessed the first major contacts between Sub-Saharan African societies and the mercantilist European nations, which were destined to leave their colonial imprint on Africa.

The overwhelming majority of Africans at that time were engaged in subsistence farming. As most soils of tropical Africa tended to be light, low in plant nutrients, easily leached by heavy rains and scorched by the sun, the farmers adjusted to these natural deficiencies by means of shifting cultivation, usually based on slash-and-burn techniques. In most parts of the savannah and bush

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country shifting cultivation was facilitated by the virtually limitless supply of land. The system discouraged permanent individual rights in land. When communities moved, individual farmers could stake out their new fields with family labor as the chief defining constraint. Communities were typically delineated by kinship. A political concomitant of shifting cultivation was that chiefship tended to be over people rather than land; European-style feudalism based on land-scarcity was unknown. Other types of agriculture were practiced by nomadic herdsmen, like the Somali and Masai.

Commerce was nourished by, and in turn nurtured, the West African medieval empires of the Niger bend, such as Ashanti, Dahomey, Mali, Benin, which flourished in the 14th-19th centuries. Some of these empires were founded on the long-distance trade which took gold, ivory and slaves from West Africa across the Sahara to the Maghreb and Europe in return for salt, cloth and beads. Profits from the trade not only sustained some of the states, but also nurtured craftsmen (jewellers, weavers, iron-workers, potters, masons, carpenters), who met the local needs of the better-off-merchants and nobility. Sometimes, as in Benin, the rulers derived power and profit from their control over long-distance exchange. At other times state power relied less on the cash nexus and more on protection offered their subjects, favors and a variety of religious, judicial and political services. Conversely, commerce did not always require strong state systems. From the viewpoint of long-run economic development, the traditional West African long-distance trade suffered from one grievous handicap: it relied much too heavily on assets like gold, ivory and slaves that were found or captured, and very little on production.

In comparison with contemporary Europe and Asia, one aspect of Sub-Saharan African societies is sharply silhouetted: their technological backwardness. Some key examples: one Bronze Age invention prevalent throughout Eurasia, the plow, had not yet reached Sub-Saharan Africa (except Ethiopia). This meant animal power could not be harnessed to farming. Another weakness was in adapting the wheel to its numerous potential uses, including harnessing wind and water power and as an integral element in various irrigation devices.

The advent of European mercantilist interests on the west coast of Africa in the 15th century had profound consequences. First, the existing overland trade links were gradually supplanted, in relative significance, by the European-controlled maritime commerce linking the West African coast to Europe, as well as points on the West African coast to each other. One important consequence of European mercantilism was the massive boost it gave to the slave trade. Slavery had existed for many centuries and in many forms, but pre-colonial Africa had never developed large-scale plantation economies. The European conquest of the New World led to the institution, in the Americas and West Indies, of large tropical-crop plantations (sugar, tobacco, cotton, coffee). Millions of captives were shipped across the Atlantic in the course of the four centuries during which the trade flourished. Aside from the severe human cost to those directly afflicted, this process drew off from the continent human beings at their most productive ages. Worse still, it encouraged tribe to fight tribe and encouraged conflicts within tribes. The slave trade plunged vast stretches of Africa into anarchy. The final consequence of Europe's 15th-century coming to Africa as that it led, step by step, to the extension of European military and political domination over the continent, culminating in the 1880s when the continent was comprehensively carved up among the rival European powers.

The impact of colonialism (1890-1960). The early years of colonial rule were characterized by a mixture of physical repression and the founding of the infrastructure of modern economic states. In their territorial expansion in quest of commercial opportunities and minerals the European chartered companies and concessionaires, in collaboration with their imperial mother-nations, fought bloody battles of subjugation. On the other hand, colonial rule put an end to slavery and slave-raiding. And the railways and roads did get built; they inevitably opened up vast tracts of African hinterland and gave an enormous fillip not only to the European-controlled mining, but also to African commercial agriculture. Given the earlier paucity of wheeled transport, and the susceptibility of pack animals to fly-borne diseases, the impact of railways and lorries on African economic development was enormous (some adverse consequences were the more rapid spread of communicable diseases). New crops, like cocoa, sisal and cotton, were introduced and propagated. A start was made with public health facilities to control the effects of diseases affecting man and livestock. Schools were built, with the missionaries taking the lead. Above all, once the colonizing conflicts had been fought to their conclusion, the system provided the minimum of public security necessary for economic development.

In sketching some of the lasting elements of the colonial imprint, it is useful to distinguish two types of experience: the 'white-settler colonies' of East and Central Africa; and the peasant economies of West Africa.

There are three major characteristics of the economic evolution of the 'white-settler' colonies, as exemplified by Kenya and Southern Rhodesia (Zimbabwe). First, the development of African commercial agriculture was retarded, at least until the early 1950s when the policy was reversed. The colonial administration used policies of land alienation, discriminatory orientation of government research, credit and extension services, controls on prices and markets, and outright bans on African farming of certain crops, to develop and maintain the profitability of European farms. The "African reserves" served as pools of wage labor to the European farms.

Second, modern industry began much earlier in the settler colonies than in the peasant economies of West Africa. One reason seems to have been the pro-industrialization influence of a resident European population which possessed the necessary technical, managerial and entrepreneurial skills, the requisite contacts with home-based firms, and the political leverage to influence the colonial administration to grant support and protection to nascent industrial activities. Where local industry (albeit controlled either by Europeans or Asians) had an early start, the disruption of trade caused by World War II gave a major import-substituting boost to industrialization.

Third, the settler colonies were generally characterized by a tradition of state intervention in the economy. From the earliest years of British colonial rule in East and Central Africa state monopolies over export crops were set up. Restrictions were imposed on who might sell what to whom. Industrial licensing, currency restrictions, trade controls and tariffs proliferated. World War II greatly increased the variety and intensity of the colonial administration's intervention in these economies.

The outstanding differentiating characteristic of the West African peasant economies was the linch-pin role of African farmers throughout the colonial period. Except for a few plantations in the Ivory Coast, Liberia and Nigeria, the market-oriented production of both export crops and foodstuffs was in the hands of African peasants. This had three major economic consequences. First, by the mid-20th century the average West African peasant from the Gold Coast (Ghana), the Ivory Coast, Nigeria or Senegal enjoyed a much higher standard of living than his counterpart in East and Central Africa (except for some regions of Uganda). Second, this long history of commercial farming provided the experience necessary for large numbers of Africans gradually to move into wholesale and retail trade, transport and various artisan activities. Third, amongst the African farming population there evolved a much higher degree of economic differentiation than in East and Central Africa.

While the colonial period was marked by a prolonged agricultural boom, industrialization lagged in West Africa. One reason given by economic historians is the highly monopolistic character of the export-import trade in these economies. As early as 1930, four companies accounted for 60% of the export-import trade. The monopolistic position was strengthened and preserved through to the mid-1950s and was successfully deployed to discourage any local manufacturer from taking over any significant share of the market. Nor was there any white-settler population of consequence to exert the pro-industrialization supply-side pressures which existed in East and Central Africa. After the mid-1950s, however, there was a massive spurt in industrialization, when the surge in imports broke down the old oligopolistic barriers around the import trade and induced a series of market-protecting local industrial investments by the previously dominant trading firms.

World War II witnessed an enormous increase in the responsibilities and roles of government in the Allied nations of the West. This trend found reflection in much more actively development-oriented policies of the colonial administrations. This was the period when "colonial planning" effectively took shape as a result of a mixture of efforts by the local authorities to express their needs in a more explicit form, and by the metropolitan powers to integrate capital outlays for overseas territories in their own national plans. This was particularly true for the French colonies and somewhat less so for the British. Furthermore, financial aid in the former was always exclusively in the form of grants and quasi-grants, whereas loans, mostly on soft terms, were the rule in the latter. Investment was mainly oriented toward infrastructure, especially highways and ports. At the same time the welfare of Africans became a more explicit concern of colonial policies. Expenditure on African-oriented agricultural support services also increased. Besides a few large, ill-conceived, and widely publicized attempts at large-scale mechanization (the Kongwa scheme in former Tanganyika, the Casamance groundnut scheme in Senegal), there were serious though unequally successful efforts at organizing African farmers at village level for productive and distributive purposes ('co-operatives,' 'sociétes de prévoyance,' 'paysannats indigènes' etc.).

The post-war era was also one of intensified state intervention in trade and money, especially in the Franc zone area. This resulted in trade arrangements especially advantageous to exports from the metropole and beneficial to the colonies in terms of stable prices and assured markets for their primary products. The system had lasting effects among former French colonies, in the form of regional and subregional common markets and common currency arrangements that have been instrumental to this day in facilitating movement of goods and people alike, and minimizing balance-of-payments problems among members that have adhered to the Franc area system.

Initial conditions at independence. Most of the Sub-Saharan African countries attained political independence in the late 1950s and 1960s. The majority of these countries were blessed with relatively favorable arable-land-to-population ratios at independence. However, the quality of land was typically poor because of topography and climate. In about three-quarters of Sub-Saharan Africa rainfall is scanty. Where rainfall is bountiful, year-to-year fluctuations are great, and the intraseason pattern frequently uneven and unpredictable; both aspects hinder rainfed agriculture. Across most of Sub-Saharan Africa soils are derived from old acid parent rock which is poor in calcium and plant nutrients. And if green cover is removed, the high heat of the tropical sun and/or heavy spasmodic rainfall easily threaten the thin layer of humus on which plant life depends. When that happens the soils readily turn into infertile laterite. There are, of course, significant exceptions to this endowment of poor soils, in the shape of the rich volcanic soils in some East African highlands and the alluvial clays of the coastal plains. The tropical climate of Sub-Saharan Africa can constrain human endeavor. The high heat and humidity engender lassitude, and these climates are very hospitable hosts to a formidable range of parasitic and infectious diseases, which exact a toll in morbidity and death; the absence of winter, as a natural killer of vector-borne diseases, is a significant factor. The most well-known of these scourges are bilharzia, malaria, river blindness, sleeping sickness, parasitic worms, yellow fever, cholera and leprosy.

Minerals were an important magnet drawing colonialists to Africa. But their recent and foreseeable role in economic development is limited to a handful of countries where the known mineral resources are concentrated: Zambia, Zaire, Botswana, Gabon, Sierra Leone and Zimbabwe.

For most Sub-Saharan African countries the colonial heritage of trained indigenous manpower was abysmally small. The rapid development of schooling facilities after World War II had ensured that the primary-school enrollment ratios by 1960 (25-60 percent in most cases) were not dramatically lower than in other developing areas. But the proportions in secondary and higher-level education were very much lower--at most 2 or 3 percent in secondary and very few at university level. As for Africans with experience in administrative, managerial, financial and technical pursuits, such cadres were extremely thin.

Apart from formally trained manpower, the indigenous populations of the newly independent African states were endowed with very limited entrepreneurial experience. In East and Central Africa, commerce, finance and industry had been almost exclusively the preserve of Europeans, Asians and Arabs. The entrepreneurial heritage in some of the West African economies was more promising. The long exposure of Africans to commercial farming and then commerce had begun to spawn significant numbers of small African enterprises engaged in the craft trades of tailoring, woodworking, goldsmithing and motor repair, as well as more mainstream manufacturing activities like baking, printing, bottling, sawmilling, soapmaking and even manufacture of electric motors. The heritage was, of course, unevenly distributed with Nigeria, Ghana and Senegal leading the field.

At independence, almost all the Sub-Saharan African nations were small open economies with foreign trade accounting for 20% or more of national product. Typically the export trade was characterized by heavy dependence on a few primary commodities. Except in the mineral-producing countries, these primary commodities were agricultural items like coffee, cocoa, tea, palm-oil, cotton, oilseeds and sisal. There were few inter-industry links, since the overwhelming bulk of the processing of the exportable agricultural surplus had been conducted in the imperial, importing nations. Barring the mineral producers, agriculture was the dominant sector, accounting for 40-60% of national product, with half or more of value-added being generated in subsistence activities which provided means of livelihood to the majority of the population. The modern infrastructure of railways, roads, banks, power and water utilities and commercial networks serviced the links between the productive cash economy (commercial farms, plantations and mines) and the former metropolitan nations which purchased its produce in return for manufactured producer and consumer goods. Urban communities were small, but usually growing rapidly.

At the end of their day the colonial administrations loomed large in the economic life of these nations, not only in national accounting terms, but also in the scope of activities they controlled through legislation, administrative fiat and extra-government public agencies like marketing boards. The middle and upper levels of wage and salary scales of the colonial public sector were designed to facilitate recruitment from the colonial nations, and were thus set according to prevailing payscales in those countries; they bore no sensible relationship to the average standard of living in the African nations. Thus, it was commonplace to see ratios of 30 or 50 to 1 between top public service salaries and average (or legal minimum) wages of unskilled labor, which was in marked contrast to the ratios of 4 or 5 to 1 to be found in Great Britain or the United States. The inappropriate structure of public incomes was compounded by policies with regard to perquisites such as housing and car subsidies. This sort of "inappropriateness" also spilled over into excessively high design standards for public services such as water, lighting, health and housing.

Perhaps the strongest institutional bequest of colonialism was the concept and practices of a nation state which transcended ethnic and kinship ties. This is not to belittle the role of the African nationalist movements which helped to bring about independence, but rather to recognize that the crystallization of such nationalist sentiments and political parties were spurred in many cases by the fact of colonial rule. It is also to recognize that the geographic boundaries of the sub-Saharan African states were usually the outcome of colonial history, and frequently not congruent with indigenous cultural and linguistic demarcations. Nationhood, in the form of the apparatus and practices of a modern state, came to Africa very fast and created formidable new challenges to expand traditional loyalties, which tended to be limited to kinship groups and tribes, to embrace the nation. Stanislav Andreski has argued (e.g. Development Digest, July 1969, p. 74) that the hurried onset of statehood and very rapid urbanization has severely diluted the traditional (largely tribal and in rural settings) moral restraints without there being time enough to nurture new supratribal loyalties and obligations to the institutions of the modern state, thus leading to a situation of 'moral disorientation,' conducive to unrestrained and highly individualistic pursuit of wealth and power through any means at hand. This is probably too extreme a view. It may be more appropriate to recognize that since independence there has been a race to instill and nurture the notions of supratribal loyalties and ethics before customary webs of obligation won out (or crumbled too early), a race which may have been temporarily lost or won in some countries, but which has almost nowhere been run to a finish.

Colonial rule not only left behind the large new apparatuses of modern states, but also a heritage of public intervention to solve perceived problems of the populace. To some extent the latter-day paternalism of colonial administrations bred, amongst the affected populace, a syndrome of dependency toward the state in respect of free (or subsidized) services such as schools, hospitals, water, sewerage, roads, lighting and housing. While these public benefits had been mainly limited to a few urban communities where most of the colonial rulers lived, with independence the expectation of such benefits spread far wider to the much more numerous rural populations. This 'consumptionist' approach to public services was a colonial heritage with major post-colonial consequences.

Development Strategies--Two Leading Types

In attempting to review the post-independence development policies and experience of the Sub-Saharan countries, an analyst is confronted by the enormous variety of policy choices and diversity of results. To do justice to this richness of experience would require a separate study of each of 40 odd countries. However, the high degree of abstraction necessary in a paper as short and broad-ranging as this one forces a search for the commonalities in policies and experience.

It is useful to distinguish between two broad kinds of development strategy pursued by the post-colonial Sub-Saharan African nations. The first was characterized by some or all of the following elements:

(i) a high level of state ownership and investment in modern sector industry, agriculture, transport and commerce, combined with a penchant for public control over resource allocation in all key sectors;
(ii) rapid Africanization of middle- and high-level jobs in the economy;
(iii) a deliberate effort to 'force' the pace of industrialization and a willingness to accept the resultant skewing of the structure of incentives against agriculture; and
(iv) a skeptical attitude towards foreign trade and investment, which typically spawned inward-looking production priorities rather than efforts to expand foreign exports.

Using the first feature for a short-hand label, this strategy may be termed 'étatist.' The second strategy boasts some opposite characteristics:

(i) relatively greater reliance on markets, especially international market forces, for guiding investment and output allocation, with state enterprises limited *mainly* to the traditional public utilities and various types of infrastructure which support the directly productive sectors;
(ii) slower Africanization of high- and middle-level manpower;
(iii) a greater willingness to let the pace and character of industrialization be governed by market forces; and
(iv) a tendency to view external trade and investment as a source of gains.

Following the earlier convention, the short-hand label for this strategy is 'market-oriented.' This label merits some qualification. Virtually all Sub-Saharan African governments were highly interventionist, though the étatist ones were considerably more so, especially regarding the degree of state ownership of productive enterprises. Perhaps the crucial distinguishing characteristic of the market-oriented countries was the degree to which they permitted international market forces to govern their pattern of economic specialization; étatist countries were far more prone to try and swim against world market tides.

We will focus on a limited number of countries which followed the étatist strategy--Guinea, Ghana, Sudan, and Tanzania. Countries which have followed a more market-oriented strategy include the Ivory Coast, Kenya and Malawi. In terms of the number of countries and the populations they contain, the étatist strategy has been the more influential in post-colonial Sub-Saharan Africa. The countries chosen for comparison represent clear cases of strategy choice, and have good economic data; none had oil or minerals for export which would bias the comparison.

Development experience. A base period (1960) snapshot of the seven countries reveals broad similarities in the structure of output. Agriculture accounted for two-fifths or more of total value-added, with, as one would expect, the poorest countries like Malawi and Tanzania displaying the higher shares. Manufacturing accounted for less than 10% of GDP in all countries. Its share was usually comparable to that of the transport-and-communications sector and invariably less than that of trade. There were greater differences in the disposition of national output. Leaving aside the exceptional case of Malawi (with negative saving in 1960), gross national savings ranged from a low of 5.4% of market-price GNP in Guinea to a high of 16.2% in Ghana. The share of gross domestic investment in GNP varied from 8.7% in Sudan to a high of 24.7% in Ghana, where the 'big-push' development policies of the Nkrumah government were well underway. Imports of goods and non-factor services ranged between a quarter and a third of GNP, with exports averaging a little lower, except for low 12% values for both in the Sudan.

Growth rates of real GDP, agriculture and manufacturing between the early 1960s and 1975 are summarized in Table 1. First and foremost, it is clear that the market-oriented countries had a significantly higher rate of growth of GDP, averaging 6.9% a year, than the étatist nations which averaged only 3.8% a year. Indeed, Malawi and the Ivory Coast are the only two nations in all sub-Saharan Africa which achieved growth rates of 7% or higher over an extended period and without the benefit of mineral exploitation. In Tanzania, Ivory Coast and Kenya growth was slower after 1970 than before; part of the explanation must lie with the vicissitudes of the international economy and the droughts which affected agricultural production in many countries in 1973-1975. A growth rate in agriculture greater than 3% seems to be a necessary, if not a sufficient, condition for relatively rapid GDP growth. There is no apparent correlation between the *achieved* pace of industrialization and the extent to which the objective was considered central to development policy. Thus manufacturing in Malawi and Ivory Coast, neither of which gave primary emphasis to industrialization, sustained annual growth rates of 13 and 10%, respectively, while in Ghana which slanted development policies in favor of industrialization the long-term industrial growth rate was only 2.6% per year. While the share of manufacturing in GDP stagnated around 10% in Ghana between 1960 and 1974, it grew from 7.1% (1960) to 14.2% (1975) in the Ivory Coast and from 5.8% (1960) to 14.5% (1975) in Malawi.

Table 1. Growth in real value added
(per cent per year, at factor cost)

	Period†	GDP	Agriculture	Manufacturing
Étatist countries*				
Ghana	1965–1974	2.8	3.9	2.6
	1965–1970	2.3	3.9	4.4
	1970–1974	3.3	3.8	0.2
Guinea	1960–1975	3.8	2.8	11.3
	1960–1970	3.6	2.7	14.7
	1970–1975	4.4	3.0	5.9
Tanzania	1964–1975	4.8	2.9	7.9
	1964–1970	5.4	3.4	10.5
	1970–1975	4.2	2.3	4.7
Market-oriented countries				
Ivory Coast	1960–1975	7.3	3.7	10.0
	1960–1970	8.1	4.5	11.3
	1970–1975	5.5	2.1	7.6
Kenya	1964–1975	5.8	3.2	8.4
	1964–1970	6.6	4.7	7.2
	1970–1975	4.9	1.6	9.9
Malawi	1964–1975	7.5	4.8	13.0
	1964–1970	6.3	3.7	15.1
	1970–1975	9.0	6.2	10.5

Source: World Bank data.

*** Data for Sudan were under revision.**

† For each country the longest possible period with consistent data has been used and then divided into two subperiods around 1970.

Developing agriculture. Both sets of countries inherited economies in which agriculture was by far the largest sector, providing livelihood to 80% or more of the population, the vast majority of whom were smallholders. Étatist nations were prone to emphasize structuralist approaches to agricultural development over gradualist ones. The former approach was typified by the concentration of scarce public capital and trained manpower on a few large-scale schemes, and/or emphasis on state-sponsored institutional reorganizations of the rural sector. Thus in Ghana during the 1960s newly established and mechanized state farms received the bulk of agricultural development funds, while the extension service for smallholders languished. This led to the deterioration of extension services, the politicization of credit allocations and the antagonization of the peasantry. In Tanzania, between 1961 and 1967, public development capital was lavished on a handful of village settlement schemes which suffered from premature mechanization, excessive investment in social services and an unwarranted degree of what Dumont has termed 'spoon feeding. In 1967, the economic differentiation among the peasantry, resulting in part from the uneven advantage taken of these services, sparked a series of egalitarian Government institutional initiatives, including the 'ujamaa' campaigns, the 1972 decentralization of Government and the 1974-1976 crash villagization program. While these initiatives were aimed at creating a framework conducive to long-term, broad-based rural development, the prolonged flux in the peasant's institutional environment exacted a significant short-term toll in foregone rural production and incomes. In Sudan, investment, research and qualified manpower resources were concentrated throughout the period on a few massive, state-run irrigation schemes (such as the Managil extension of the Gezira, the Khasm-el-Girba scheme, and the recent Rahad project) and some programs in support of private, mechanized farms. The 10 million people earning a livelihood from traditional rainfed smallholder cultivation were residual in the agricultural development effort.

In contrast, the market-oriented countries made support of private peasant production the main plank of agricultural development policy. Though these countries tended to steer clear of direct state production in agriculture, there was no lack of public investment in infrastructure, research, marketing, extension and credit facilities. Thus it is noteworthy that agriculture was receiving 36% of total public investment in the Ivory Coast in the period 1966-1970, compared to 30% in Tanzania in 1974-1975. The market-oriented countries sustained and expanded successful programs of adaptive research in individual cash crops. In the Ivory Coast specialized, long-established research institutes for coffee, cocoa, oilcrops and cotton worked closely with the 'development societies' for these crops. In Kenya, the newly-independent Government built on the inherited research programs in coffee, wheat and pyrethrum. The Kenya Tea Development Authority pioneered a system of 'tea roads,' smallholder extension, and organization of collection and process functions which permitted smallholders to become efficient producers of tea--usually regarded as a plantation crop par excellence. The successful adaptation of hybrid maize for smallholder cultivation in high-potential areas of Kenya was a rare success story of adaptive research in foodcrops in Sub-Saharan Africa. The governments in market-oriented countries usually provided qualitative encouragement to progressive farmers, instead of viewing them as unwelcome harbingers of an entrenched kulak class. For example, in Malawi, the 'Achikumbe' program provides various kinds of benefits and recognition to smallholders who consistently achieve certain high standards of husbandry and market orientation.

The external sector. Given the initial openness of the Sub-Saharan African economies and the foreseeable demands for increased import flows, a successful, long-term export policy was a prerequisite for a sustained development effort. That was easier said than done. The initial export structure of these countries was heavily dependent on a few agricultural commodities. The choice facing most was whether to deepen the existing specialization further on the basis of comparative advantage or attempt to nudge the evolution of export competitiveness away from agricultural products. A strong attraction of the latter choice was the very sharp declines in external terms of trade that these countries had experienced between the mid-1950s and 1960-1962, and which was an important explanation for the ambivalence towards primary exports shown by many newly independent countries. The market-oriented countries cast their lot on the side of continued specialization in agricultural exports, with the partial exception of Kenya which also pursued manufacturing export markets in the partner countries of the East African Common Market. Not coincidentally, these were also the countries which sustained the most favorable environments for private peasant agriculture. The étatist nations on the other hand were, on balance, less favorably disposed towards both private peasant agriculture and further specialization in agricultural exports.

The information in Table 2 supports some surprisingly clear-cut judgments on the relative efficacy of these choices. First, the fears of a long-term decline in the terms of trade were not misplaced. Comparing 1954-1956 to 1973-1975, all countries but Sudan experienced substantial declines in their commodity terms of trade. But the real issue was whether, given the correctness of such a prediction, these African countries had a viable alternative export policy to one of continued specialization in agricultural exports. If the past two decades of experience are any guide, the answer seems to be negative. Comparing 1954-1956 to 1973-1975, the export volumes of the Ivory Coast, Kenya and Malawi increased five-fold, four-fold and three-fold, respectively, while they failed to double for Ghana, increased by about 50% in Tanzania and stagnated in Sudan. What is even more telling is the record on the purchasing power of exports. These indices stagnated for Ghana and Sudan, and rose by a third in Tanzania. In contrast, the index tripled for the Ivory Coast and more than doubled for Kenya and Malawi. The market-oriented countries were clearly able to generate volume increases which far outweighed adverse price trends, through a policy of continued specialization in agricultural exports combined with increasing diversification among agricultural commodities.

Table 2. Indices of export volume, terms of trade, and purchasing power of exports: 1970 = 100

	1954–1956	1960–1962	1966–1968	1973–1975
Etatist countries*				
Ghana				
Export volume	66	85	71	123
Terms of trade	148	90	94	75
Purchasing power	98	75	67	92
Sudan				
Export volume	65	84	80	60
Terms of trade	119	89	97	132
Purchasing power	77	75	78	77
Tanzania				
Export volume	52	78	103	76
Terms of trade	123	95	102	111
Purchasing power	64	73	102	84
Market-oriented countries				
Ivory Coast				
Export volume	29	56	83	157
Terms of trade	139	77	95	79
Purchasing power	40	43	80	125
Kenya				
Export volume	25	63	89	101
Terms of trade	154	96	97	87
Purchasing power	38	60	86	88
Malawi				
Export volume	48	51	102	148
Terms of trade	111	100	89	77
Purchasing power	53	51	90	113

Source: *UNCTAD Handbook of International Trade and Development Statistics*, 1976.
* Data are not available for Guinea.

Entrepreneurship and industrialization. The lack of a strong class of African industrialists tended to confront policy-makers with a choice between continuing with the colonial heritage of an industrial sector owned and controlled by private non-African groups (including both foreign transnational investors and local ethnic minorities), or 'Africanizing' modern industry through nationalizations and public investment in industrial plant. Most countries veered towards the latter path. Ghana and Guinea led the way immediately following their independence in 1957 and 1958, Tanzania followed suit after the 1967 Arusha Declaration, and Sudan in 1969. The three market-oriented countries, the Ivory Coast, Kenya and Malawi, continued to rely predominantly on foreign private investment and management for industrial development.

Thus far the development of successful African industrial entrepreneurship, whether in private or parastatal modes, has been limited. At the time of independence the greatest promise for private African entrepreneurship appeared to be in some of the coastal West African economies like Ghana, Nigeria and Senegal. But very soon after independence, these countries activated strong import-substitution policies, including detailed administration of import and industrial licenses, which tended to favor the larger established foreign subsidiaries and new government industries, and be biased against emerging, small-scale indigenous manufacturers. These policies, together with the existing handicaps of the environment, inhibited the evolution of private African entrepreneurs. In the lower-income East African countries it was probably too early to expect a significant transition of Africans from cash farming to industry. In all these countries the availability of relatively well paid and secure government jobs dampened proclivities for industrial ventures. In the étatist countries like Ghana, Guinea, Sudan and Tanzania, the emergence of private industrial African entrepreneurs was further inhibited by the anti-private-sector stances of government policies.

Almost by definition, the scale of state entrepreneurship in the industrial sector of the étatist countries has increased greatly. Given the relative infancy of the industrial sector, it is probably too early to form a definite evaluation of African state entrepreneurship. However, in most countries policies of import restrictions, tariffs, preferential access to domestic and imported raw materials and intermediate imports, confinement schedules and subsidized credit and equity terms have created a highly protective framework which discourages striving for efficiency. Many of these features of the macro-policy-frame are also to be found in some of the market-oriented countries. But in the case of parastatal firms the macro-policy problems are compounded by the weakness of firm-level incentives for workers and managers, their inexperience, the multiplicity and diffusiveness of objectives, and the transference of bureaucratic procedures from civil-service backgrounds. Comparisons of product per unit of labor or capital in parastatal versus private firms show higher productivity in private firms by some 100 percent in Ghana, and by 20-40 percent in Tanzania (depending on the measure used).

Wage policy and its effects. Both the colonially-bequeathed wage structure and the subsequent course of policies had significant implications for growth and income distribution in the Sub-Saharan African countries. The colonial period bequeathed a widely divergent public pay structure, which was mirrored in the urban private sector. Not only was there an enormous difference between the top European salaried official or company manager and the unskilled African wage-earner, but the wage of the latter had had to be set high enough to attract rural peasants with a relatively high reservation price into 'permanent' urban wage labor. Around the end of the colonial period these unskilled urban wage rates tended to become codified in minimum wage legislation. After independence there was rapid Africanization of the administrative grades of the civil service, but without any significant change in the pay structure. One major reason for this was that it was politically extremely difficult to reduce the pay of senior African civil servants substantially so long as the old pay scales (or even better ones) were necessary to retain many of the ex-colonial expatriate staff in the more technical government functions. And in the private modern sector, foreign firms continued to pay their predominantly expatriate senior staff the same high salaries as before. Thus, post-independence pressures to reduce the massive disparities between the top and bottom of the urban pay structure could be accommodated more easily by raising the pay scales at the bottom. This is what happened.

There were several significant consequences. First, during the first decade after independence the gap in real earnings between smallholder peasants and urban unskilled workers or clerical staff widened greatly. Consequently the demand for such urban formal-sector jobs expanded much faster than supply, and the positions had to be rationed --usually on the basis of educational qualifications, such as primary-school leaving certificates. This, in turn, generated a massive demand for education, where the emphasis was on the diploma (rather than the content of education) as the passport to formal-sector jobs. There was no comparable reward attached to the more difficult process of acquiring vocational or craft skills. The supply of education increased rapidly, especially in rural areas, partly in response to the vastly increased demand and partly to well-grounded desires to reduce illiteracy and ignorance. Armed with the necessary certificates large numbers of rural youth migrated to urban centers to engage in the lottery for relatively well-paid formal-sector jobs. As the rate of growth of such employment typically lagged behind the combination of natural increases in existing urban labor force and the growth of migration to towns, the result was increasing urban unemployment, the growth of an informal sector, and greater urban poverty, all relatively new phenomena in Sub-Saharan Africa.

Thus the adverse consequences of wage policy included:

(i) widening urban-rural income differentials;
(ii) the emergence of urban unemployment and poverty;
(iii) excessive investment in the wrong type of education;
(iv) price inflation and reduced government savings;
(v) increased protection of the nascent industrial sector;
(vi) increased orientation within industry in favor of capital-intensive activities; and

(vii) a failure to reward craft skills necessary for the evolution of African non-government enterprises.

In varying degree, these policies and consequences may be found in both étatist and market-oriented countries. The presence of a well-developed mineral sector tended, as in Zambia, greatly to accentuate the problems of an inappropriate wage structure. Labor earnings were typically very high in the capital-intensive mineral sector and tended to impart a strong upward bias to the entire formal-sector wage structure.

Policy Priorities for the Future

Given the stage these Sub-Saharan African countries had reached by the 1980s, what are the critical long-term development issues that they must tackle to provide the best hope for self-sustaining development that helps to alleviate poverty? [Note: A major World Bank study will be published, autumn 1981, entitled: "Accelerated Development in Sub-Saharan Africa: An Agenda for Action."]

The demographic setting. Of all the regions of the world, Sub-Saharan Africa displays the highest fertility and mortality rates; and while mortality rates have been declining, there has yet to be any significant change in fertility rates; so the rate of population growth is likely to accelerate before it declines. Although historical data on mortality rates in these countries are scarce and unreliable, it is clear that over the past two or three decades there has been a significant decline, leading to increases in life expectancy at birth of 7-10 years between the early 1950s and early 1970s. Total fertility rates have remained high, in the range of 5.5-7.0, with crude birth-rates clustering around 45-50 per 1,000. Except in the two small island nations of Mauritius and Réunion there has been no significant decline in fertility. Indeed in some countries, fertility appears to have risen in recent years. Rates of population growth range between 2.5 and 3.5% per annum.

The continuing pattern of low life expectancy is attributable to extremely high rates of infant and child mortality, explained by the usual features of high incidence of communicable disease, malnutrition, gastric diseases, poor traditional midwifery and weaning practices. Where fertility is believed to have risen in recent years, it has been attributed to adult health factors such as higher fecundity and reduction of secondary sterility.

With continuing improvements in general health conditions, all those factors which will improve women's ability to conceive and bring pregnancies successfully to term will tend to increase fertility. There is much debate on the effects of urbanization and education on fertility. Parents' recognition that they cannot afford education (especially secondary education) for large numbers of children is probably the best hope for future fertility decline. Very few governments presently endorse strong family planning programs. Even when governments adopt such programs, as in Kenya, the spread of family planning measured by numbers of acceptors does not appear to be accelerating; and program activities are still mainly confined to the highly educated.

Thus the outlook for the next two decades is for continued (and sometimes even accelerating) rapid population growth. Ultimately, as improvements in child mortality reduce the number of desired births and education offsets strongly held pro-natal feelings, fertility can be expected to decline. In the meantime, economic policy-makers must plan on the basis of high rates of population growth. Two obvious consequences of this growth will be: (i) increases in social service spending budgets, which should strengthen the case for institution of cost-recovery systems; and (ii) acceleration of the shift in agriculture from land-extensive cultivation systems to more scientific ones.

A strategy for agriculture. For most of these countries, in the medium and long run, the key to more rapid growth, swifter alleviation of poverty, containment of unemployment, the reduction of urban-rural income differentials, a more manageable balance of payments and a more robust basis for long-term structural transformation of the economy, lies with increasing production in the rural economy. While industrialization of the right kind can play a strong supportive role, its capacity to generate employment and incomes directly will be quite limited for decades to come. Thus, for example, in Tanzania, where the choice of industrial strategy has been the focus of sustained analysis and debate during the past five years, long-term simulations reveal that whatever their other differences, none of the strategies under consideration offers a scale of manufacturing employment greater than a mere 3% of the projected labor force by 1995. In the 1970s employment in the organized manufacturing sector in higher-income countries like the Ivory Coast and Ghana accounted for only 2% or so of their labor force. For the foreseeable future the task of providing productive employment for the growing labor force of these nations must rest squarely with the agricultural sector.

Within the agricultural sector the long-term objectives of growth, poverty alleviation and structural transformation are likely to be best served by concentrating resources and policies in favor of smallholder agriculture. Smallholder agriculture offers the best opportunities for transforming abundant resources of land and labor into output, while economizing on scarce factors of capital and foreign exchange. This is true both for the present endowment of resources and for likely future technical innovations.

Large-scale, capital-intensive agricultural modes (state farms, private estates) are likely to play only a limited role in the optimal long-term strategy for agricultural development in Africa. Such capital-intensive agricultural modes (at least, the privately managed ones) are frequently associated with higher land productivity than peasant farming. Less often they also boast greater total factor productivity. Amongst their attractions for policy-makers are the ready accessibility of their production. But there are two principal arguments against emphasis on private estates and state farms even when they pass the test of static economic efficiency. The first reason is based on equity: the benefits from estate production are likely to be distributed much less widely than those from smallholder production of the same output. The second reason follows from this: because the diffusion of their incremental incomes is limited, estate farms are less likely to set in motion the broad-based increases in rural purchasing power that are necessary to bring about a mutually supportive dynamic interaction between agriculture and domestic industry, of the kind which has transformed the economy of the Indian Punjab in the last 15 years.

The force of these cautionary remarks varies among countries. For example, in land-abundant countries like Zambia and Zaire, large farms based on hired labor may be an appropriate mode of production for quite a few years before the demographic pressures on land sharpen the issues of market pre-emption by large farms cutting off the income-earning opportunities for smallholder farming. In countries where land is less abundant, like Kenya and Ethiopia, the arguments based on market pre-emption are already persuasive. As the demographic trends press harder against the availability of land there will be more Kenyas and fewer Zambias in the future of Sub-Saharan Africa. The details of an appropriate smallholder strategy will vary, but some principal elements are likely to be common to all countries.

First, the incentive bias against agriculture present in the policy frames of most countries needs to be substantially diminished. This will require hard decisions on exchange rates, tariff structures, formal-sector wages, retail price controls, and agricultural producer prices. In addition to increasing the purchasing power of rural incomes through such policy reforms, the distribution systems must be developed to convey manufactured consumer goods upcountry to enable purchases from the increased incomes. If these actions are taken, one can confidently predict substantial increases in rural incomes and production. That smallholders will react positively to improved price incentives can be reliably asserted on the basis of the wealth of evidence from all over the globe--including Africa.

Second, throughout the greater part of Sub-Saharan Africa, population growth is gradually inducing a transition from resource-based, land-extensive farming to science-based, land-intensive practices. Virtually all studies of African farm systems carried out in the 1950s and 1960s stressed the labor-constrained nature of agricultural output; but the doubling of the population in the last quarter of a century is changing all that. Like all transitions the picture is mixed. There are still substantial opportunities for increasing output by expanding the cultivated area, both through shifts into lower quality lands and through opening up good virgin land by extension of the rail and (primarily) road networks. But the pressures for land-intensive cultivation are now being clearly felt in many areas. In Kenya 'high-potential' land is virtually exhausted and in certain pockets landlessness has begun to emerge as a significant social problem. Population pressure is also being felt in the good land areas of the Arusha, Kilimanjaro and West Lake regions of Tanzania, and in northern Ethiopia and the Sahel countries. Benneh has estimated that in recent years in Ghana the average fallow period has been reduced from 6-10 years to 2-3 years in the predominant bush fallow system of cultivation. All of this suggests that in the long term growth in agricultural output will come increasingly from improvements in the intensive use of land, stemming from better husbandry and greater use of fertilizer, pesticides and improved seeds.

Given the enormous heterogeneity of the rainfall patterns and soils and the relatively small stock of research, especially in foodcrops, the transition to a science-based, land-intensive farming strategy will be a long, slow haul. The need for location-specific adaptive research is great, especially in semi-arid zones. Special attention needs to be devoted to rootcrops and coarse grains, which are particularly prominent in African food production and consumption. Adaptive research will need to embrace biological-chemical innovations such as seed-fertilizer combinations, as well as mechanical innovations. There is an urgent need to strengthen the capacity of national and regional research organizations to generate an efficient sequence of technical innovations that are feasible and profitable for small farmers.

High-yield 'technical packages' will need to be combined with improvements in cropping and tillage practices. To ensure that all this complex information is readily available to the farmer will require wider and faster-reacting extension service systems than are presently available in most countries. Providing for a dialogue between African farmers and researchers is difficult at present, but is essential for increasing the impact of research on farm productivity and output.

In present-day Africa irrigated agriculture is expensive and technically demanding. In the short and medium run it makes more sense to focus adaptive research and development programs on the predominant rainfed mode, including the semi-arid areas which are increasingly being brought under cultivation. But in the long run irrigation could have a greater role, and some attention needs to be given to accumulating hydrological data and beginning to acquire the necessary expertise and experience for the design and management of irrigation schemes.

Third, one readily transferable technical innovation, the tractor, should be approached with extreme caution. The experience with tractorization schemes in Sub-Saharan Africa is, on balance, unfavorable. Most tractorization schemes have been characterized by overcapitalization, poor organization, inadequate repair and maintenance facilities, inefficient use of machines, high land-clearing costs and insufficient increases in output; and tractorization is typically labor-displacing. Recent research by the World Bank on the comparative economic profitability of technologies found tractors inferior to oxen cultivation, even when it was assumed that all of a village's land was farmed as one unit; this was even more true for individual peasant holdings.

This does not mean that African farmers should be condemned in perpetuity to the presently prevailing system of manual cultivation based on the hoe. The potential from improved tools and implements is particularly promising for oxen-based farming systems, wherever soils, topography and the tsetse fly permit. Indeed, a fourth element of a smallholder-oriented development strategy would be the institution and encouragement of oxen cultivation, and related propagation of new tools and implements. Control of the tsetse fly is important. Breeding programs need to be developed for stronger, more effective oxen for cultivation. A broad range of implements and tools has to be developed, tested, produced and marketed; and animal power should be harnessed to a wider range of farm tasks than is currently the case. The integration of draft animal power into farming practices will also require changes in social customs and attitudes towards the role of cattle and in the rules governing their access to grazing land. Furthermore, local small-scale manufacture of a widening range of hand-tools and animal-power implements (such as plows, cultivators, seed-fertilizer drills and planters) can stimulate the growth of rural-based manufacturing activities, especially the growth and diffusion of metalworking and other technical skills essential for the evolution of broad-based manufacturing capabilities and non-farm employment opportunities. The burgeoning rural workshops of India, Pakistan, Taiwan and China have proved to be fertile ground for the development of efficient and increasingly sophisticated small-scale manufacturing enterprises.

The fifth component of a smallholder strategy must be to reduce the transport and marketing margins between the peasant and the point of final sale. Principally, this will involve improvements in physical transport infrastructure, especially feeder roads and storage facilities, and measures to increase the operating efficiency of marketing and transport intermediaries. The inefficiency of parastatal marketing and transport agencies is a particularly pressing problem in étatist countries, where their role is much greater.

The role for industry. Though the manufacturing sector now contributes from 10 to 15% of GDP in the Sub-Saharan African countries, its contribution to employment has been no higher than 2-3% of the labor force (the figure may be 3-6% if various informal-sector units are also included). Typically 80% or more of industrial value-added is in import-substituting activities, principally in 'early-stage' lines like food and beverage processing, textiles, garment manufacture, wood products, paper and printing, but with a sprinkling of very capital-intensive projects in cement, fertilizers, metal-processing and petroleum-refining. There is a substantial bias in policy within the industrial sector in favor of import-substituting activities and against production for export. There is widespread economic inefficiency in industrial activities attributable to a variety of causes:

(i) lack of competitive pressures due to heavy protection granted by the policy frame;
(ii) uncertain and chaotic implementation of quantitative import restrictions, confinement schedules and other market-fragmenting devices;
(iii) scarcity of management cadres and middle-level industrial skills;
(iv) inefficiencies and interruptions in supply of key supporting infrastructure such as transport, power and water;
(v) virtual absence of industrial consultancy and technical services;
(vi) policy discrimination against small-scale enterprises, which are frequently the training ground for indigenous entrepreneurs;
(vii) special problems of parastatal enterprises, such as diffuse objectives, excessive and insufficiently co-ordinated government intervention, and weak incentives for managers and workers.

The nub of this summary is not that Sub-Saharan African countries should not industrialize, but rather that certain kinds of costly errors and 'non-solutions' should be soft-pedalled, while some positive actions are supported.

This should not be read to mean that there is never a sound case for protecting industry. The generalized infant industry arguments (such as skill acquisition, growth of entrepreneurship) may well warrant a moderate degree of special advantage for industry relative to other sectors. Ideally, this should be at a uniform rate (20-30% as a rule of thumb) for all industrial activities and should not discriminate between import-substituting and exporting options. There may be certain exceptional cases which warrant greater inducements for special reasons. Thus the metal-working sector may be particularly favored for its special possibilities for skill acquisition and the longer-term capability for indigenous technological adaptation.

But in granting such special treatment to industry, three considerations should be kept uppermost. First, it is vitally important to keep some competitive discipline alive in the nascent industries. Second, the notion of infancy as a temporary state should not be forgotten. There needs to be some recognition of the desirability of future reductions in the special advantages initially granted. Finally, the government should not neglect the development of 'structural' supports to industry such as technical and consultancy services, accounting training, and physical infrastructure.

Formal-sector wage policies. The benefits of a lower real wage and slower growth of wage rates in future may be briefly recounted. First, a lower real urban wage will, other things being equal, mean reduced urban-rural income differentials. As a consequence the demand pull for rural-to-urban migrants would be reduced, as would the associated problems of urban unemployment and poverty. Second, a lower real wage should, in a protected, cost-plus pricing system, be associated with lower prices for manufactured goods purchased by rural dwellers. Third, lower unit labor costs in the formal sector should enhance the competitiveness of potential manufactured exports. Fourth, lower labor costs should augment corporate or parastatal surpluses and reduce government recurrent budget expenditures, thus, on balance, increasing domestic savings. In an étatist economy an increase in parastatal surpluses should not be associated with any worsening of the urban household income structure, a possibility which clearly exists in the case of private corporate surpluses which typically yield income to richer segments of the household distribution. Finally, the lower attractiveness of wage employment should increase the relative attraction of non-wage income opportunities, such as small enterprises and craft occupations. Thus, a lower real wage (and/or slower growth) should have unambiguously favorable effects on economic efficiency and growth. The effects on income equity are likely to be favorable, on balance, especially in the étatist countries.

Mobilizing domestic resources. Both étatist and market-oriented countries generally achieved considerable success in raising their revenue-to-GNP ratios between 1960 and 1975, from 10-15% up to 20% or more. However, the concomitant, and frequently faster, growth in recurrent expenditures severely constrained the growth of government savings, as measured by the ratio of recurrent budget surpluses to GNP. Given the recurrent budget claims for past development projects and continued pressure for increased social services, it would be unrealistic to expect much of a savings dividend from the budget.

Indeed, in several countries, unless the expansion of social services is accompanied by the institution of cost recovery measures and much greater local 'self-help' efforts, the government could become a significant net dissaver.

In the next decade or so, the task of generating adequate domestic savings must lie principally with the parastatals (state enterprises) and the private sector. In the étatist countries, parastatals must assume a large share of the savings responsibility. To a great extent the measures to increase parastatal efficiency will help to increase their savings. Basically a parastatal savings strategy must embrace two themes: one for generating higher gross surpluses in the first instance, and another for protecting these surpluses for investment finance instead of having them transferred to entities which use this finance for consumption. In pursuing the latter aim it may be worth experimenting with various kinds of earmarking devices.

The role for private savings is likely to remain larger. This will certainly be the case in market-oriented countries. In both groups of countries, to the extent that policy encourages the income and productivity growth of farms and small-scale businesses which combine saving and investment roles, the inducements for increased effort and investment may be enough to call forth the increases in savings necessary for self-financed investment. However, it can be anticipated that with greater urbanization the proportion of households who are not direct investors will increase. Hence there is likely to be a greater role for financial institutions to mobilize such potential household savings and allocate them efficiently. This, in turn, will require reforms in financial institutions and more active interest rate policies than have been pursued hitherto.

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Food Problems and Prospects in Sub-Saharan Africa

U.S. Department of Agriculture

[Food production in Sub-Saharan Africa has not kept pace with population growth, and with present trends the gaps will widen. The development of higher productivity in farming methods requires better economic incentives to farmers, adaptive research work, and big investments in marketing and transport facilities.]

Sub-Saharan Africa is the only region in the world where per capita food production declined over the past two decades. This decline exacts a high price in both human and economic terms. The human price is inadequate nutrition: in most Sub-Saharan countries the per capita calorie intake falls below minimal nutritional standards. The economic price of inadequate food production is an increasing demand for food imports at a time when grain prices are rising, and many African governments face acute balance of payments and foreign exchange problems.

Projections to 1990

Our study finds that the implications of this pattern are severe. Using a series of equations which project the dynamics underlying production and consumption between 1965 and 1979, we estimated import demand and unmet food needs in 1990 if historical trends continue. If 1975 real per capita income levels and producer price patterns prevailed in 1990, Sub-Saharan Africa would have an import gap of 11.5 million metric tons (cereal equivalent). Even with these imports, there would still be large unmet food needs: bringing

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diets up to minimal calorie consumption levels (about 2300 calories per person per day) would require an additional 12.4 million tons.

Even if we assume that there is positive growth in real per capita income, and that such growth follows 1965-79 patterns (essentially smoothing out the effects of the 1974-79 economic setback), the picture is disturbing. The import gap would rise to 18.5 million tons--some 11.9 million tons of this for West Africa alone. Because income growth is so unequal among regions, diets would reach adequate levels in West Africa, while major unmet food needs would persist in the Sahel, Central and East Africa. Meeting these needs would require an additional 9.1 million metric tons of cereals. If growth were to follow more recent 1974-79 trends, the regional skewing is even more extreme: under these conditions, the 1990 import gap would be 21.1 million tons--with 18.2 accounted for by West Africa, and 10.1 million more tons would be required to eliminate calorie deficits. The conclusion seems clear. If growth follows historical patterns, there will be dramatic increases in the paying demand for imports by 1990, yet very little reduction in the quantity of food required to respond to unmet food needs.

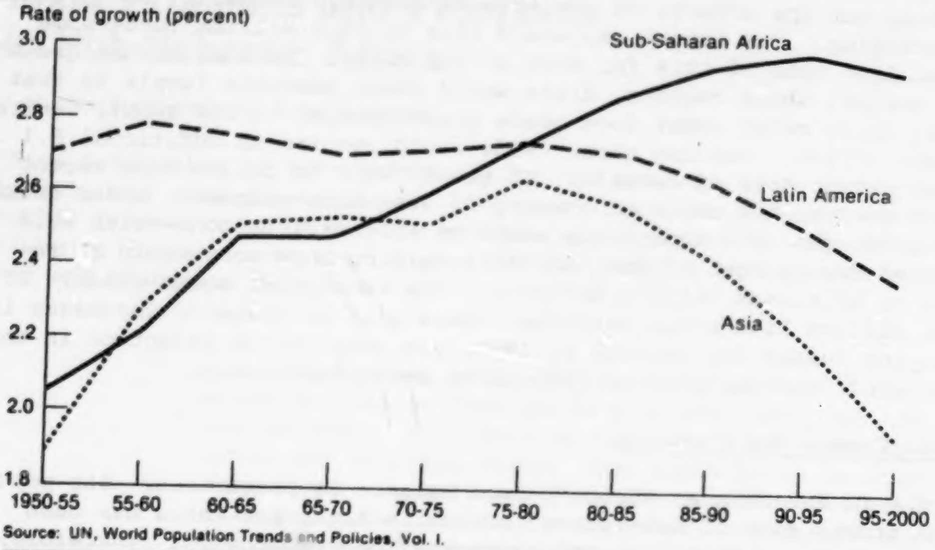
General Causes for Problems

Why is Sub-Saharan Africa's food balance so precarious? The population growth rate of Sub-Saharan Africa is high, but there has been poor growth in productivity and aggregate food production. Therefore, much of the problem appears to be on the supply side. The increasing population plus rapid urbanization are exacerbating major weaknesses in African food production and distribution systems.

Sub-Saharan Africa's population growth rate has increased steadily over the past 20 years--from 2.05 percent in the mid-fifties to 2.74 percent in the late seventies (Figure 1), and it now has the highest rate of population growth of any of the developing regions. Furthermore, population growth rates are projected to remain high over the next decade, according to United Nations projections. They are not expected to level off until about 1990, when they will average about 3 percent per year. Most of the population impact on food demand in the 1980s is built into the structure of the present population.

A special demand problem is posed by urbanization, since the interaction between urbanization and income growth creates a structure of demand which is difficult to supply from local resources. Sub-Saharan Africa is presently the least urbanized region in the world, with less than a quarter of its people living in cities. The urbanization rate, however, is high, and urban population growth rates of 5 percent or more per year are common. With an annual growth rate of 5 percent, an urban population will double within 14 years.

Figure 1



Sub-Saharan Africa, Asia, Latin America

Population Growth Rates, 1950-2000

Source: UN, World Population Trends and Policies, Vol. I.

Urbanization puts a premium on convenience foods such as bread, rice, and processed foods which are often difficult to supply from local agricultural resources. Few Sub-Saharan countries can produce wheat in any significant quantities. Rice production is possible but is frequently high in cost--both in relation to world market prices and in comparison with the cost of producing other staples. Commercial processing of local foodstuffs is not well developed. Meeting the rapidly expanding urban demand for food from local resources will require better procurement and marketing policies, improved infrastructure, greater attention to the processing and storing of local staples, and attempts to change urban food habits.

At the same time total food production in Sub-Saharan Africa has grown very slowly--about 1.8 percent per year in the 1960s and 1970s. This is below the aggregate growth rate for Asia or Latin America. Some countries actually recorded declines in aggregate production between 1961-5 and 1979. Productivity has also been low (Figure 2); African cereal yields are less than half those in Asia. Yields for pulses, as well as for roots and tubers, are about two-thirds of the Asian yields, and are not generally increasing. Thus, growth in food production has depended heavily on expanded area; increases in cultivated area have frequently offset declining yields (Table 1). In the Sahel, both area and yield have declined significantly during the last decade.

Figure 2

Yields for Cereals

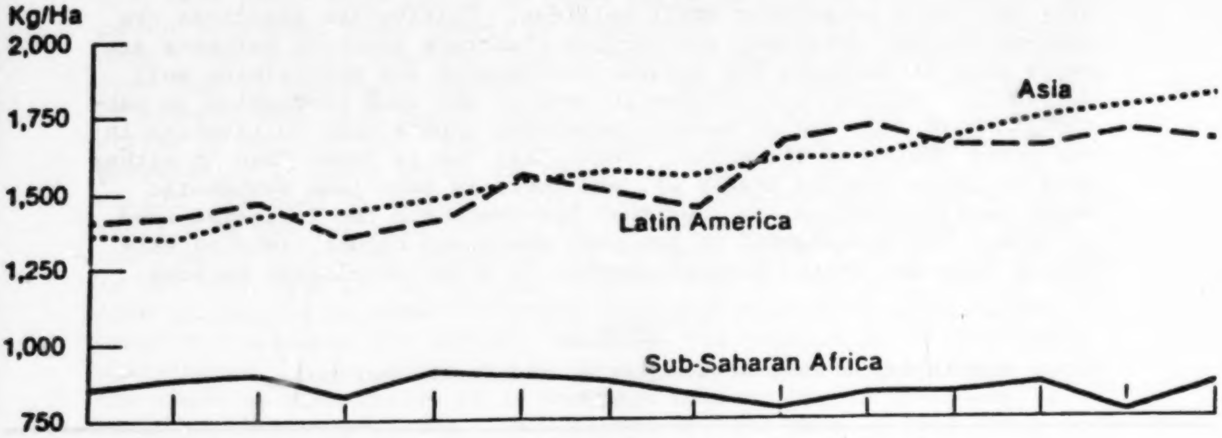


Table 1

Average annual growth rates in staple food production, yields and crop area, Sub-Saharan Africa, 1962/64-1972/74

Commodity and region	Production	Yield	Area
		Percent	
Cereal:			
Sahel	-1.6	-1.3	-0.3
West Africa	.7	- .6	1.3
Central Africa	3.2	-1.6	4.7
East and Southern Africa	2.6	1.5	1.1
Roots and tubers:			
Sahel	- .7	-1.2	.5
West Africa	1.8	.4	1.4
Central Africa	1.4	-1.7	3.1
East and Southern Africa	1.7	3.3	-1.5
Pulses:			
Sahel	1.6	-1.9	3.5
West Africa	2.0	-2.6	4.8
Central Africa	1.9	-2.0	4.0
East and Southern Africa	1.9	- .2	2.1

Source: Food and Agriculture Organization, Regional Food Plan for Africa, July 1978.

Most food production takes place in the subsistence sector. While land tenure patterns vary from region to region, farmers generally cultivate relatively small holdings. Cultivation practices are land-extensive; rotation, and various elaborate cropping patterns are major ways of managing the natural environment and maintaining soil fertility. African agriculture in general and food production in particular make less use of modern commercial inputs than cultivation in any other region of the world. Fertilizer use is lower than in either Asia or Latin America (Table 2), and there is much less systematic water control; Africa has less than one-twentieth the irrigated land of Asia. The development of improved seeds and higher yielding varieties lags far behind accomplishments in other developing nations.

Table 2

Modern input use, Africa, Asia, and South America, 1977

Area	**Percentage of irrigated land**	**Tractors per 10,000 hectares**	**Fertilizer used per hectare**
	Percent	**Number**	**Kilograms**
Africa	**1.8**	**7**	**4.4**
Asia	**28.0**	**45**	**45.4**
South America	**6.1**	**57**	**38.8**

Source: Food and Agriculture Organization, Production Yearbook, and Fertilizer Yearbook, 1978.

Basic foodstuffs are produced in large part by human labor, using simple hand tools like the hoe or the panga. The use of draft animals is more limited than in Asia, sometimes because of disease patterns in areas where the tse-tse fly is found, sometimes for cultural or economic reasons. Mechanization is used even less; Africa has less than one-sixth the number of tractors per hectare in Asia and one-eighth the number in Latin America (Table 2). With little water control and few ways of dramatically increasing the amount of work which can be done in a short time, food production is vulnerable to changes in weather and variations in the timing of key seasonal activities. This vulnerability is reflected in large variations in yields and in total production.

Many of the cultivation practices developed by African food producers were sound adaptations to their existing natural environment; one cannot attribute lower levels of commercial inputs to sheer backwardness. The natural resource base in much of Africa is quite different from that in temperate climates. Soils are more fragile, and the need to protect them from direct exposure to sun and rain led to different styles of cultivation. Rainfall patterns determine the timing of soil preparation in areas where the ground is too hard to till until rain falls. The need to maintain fertility in delicate soils led to the perfection of complex rotation and fallow systems. Nevertheless, these cultivation practices are beginning to reach their limits. The problem is not that land is, in general, scarce. On the contrary, Africa has more arable and permanent cropland than any other developing region--about 0.5 hectares per person. However, the population is not evenly distributed. Where there are major concentrations of people--as along the coast in West Africa or in the East African highlands--there is local population pressure. More important, the land in many areas is becoming scarce relative to the requirements of the prevalent land-extensive cultivation methods. Shorter fallow periods which degrade soil quality over time, and the excessive use of marginal land, are two examples of the pressure of growing land scarcity on the environment.

Over the decade of the 1980s, there will be a growing need to make a transition from land-extensive cultivation performed with hand tools to types of cultivation which can use appropriate inputs to enhance soil fertility, and can increase the efficiency of labor. Unless viable means of producing food this way can be found, increases in productivity cannot be achieved. However, such changes cannot spread far without a wider move toward more commercialized food production, supported by marketing infrastructure and policy.

Inadequate food production cannot be attributed solely to the food production sector. Two other factors loom large: the historical context within which food production occurs, and the government policies which influence food production and distribution.

Historical context. The structure of African agriculture has been heavily shaped by colonial policies designed to integrate colonies into metropolitan trading networks, and sometimes to protect settler populations. Taxation policy was instrumental in stimulating the production of agricultural exports (West Africa), as well as in providing a labor force for mining or plantation production (Southern and Central Africa), or working on settler-operated farms (Eastern and Southern Africa). Trade patterns, and the interest of European settlers, shaped the development of land tenure systems, infrastructure and commercial relations, agricultural technology, market access, and the direction of agricultural research. Several common themes emerged: African food production became a primarily subsistence activity, even in areas where substantial trade in foodstuffs existed before colonialism. Second, male participation in the off-farm work force or in cash crop cultivation frequently made women more responsible for food production. Third, lack of colonial interest in African food production meant little sustained research on food production, and hence, a relatively poor understanding of African production processes; recommendations for change were frequently counterproductive. Research on export crops was more extensive, and generally more productive.

While the historical dimensions are complex, three regional patterns can be discerned. In much of West Africa there were neither known deposits of minerals nor settler colonization. Policies were therefore directed at creating tropical agricultural exports, produced by African farmers themselves; costs of production were kept low enough to eliminate substitutes being developed within European markets. The coastal areas were linked directly with external markets, while the hinterland served as a pool of labor for the coast. In areas where land and labor were abundant, food crops were grown for domestic consumption along with the commercial export crops. Africans were frequently entrepreneurial-cultivators--using "traditional" ties to increase export crop production. In other areas, however, introducing export crops dislocated subsistence food production. The marketing of export crops here, as in other regions, was generally handled by non-Africans, while the commercialization of food marketing was limited.

In Central Africa, the production of agricultural export crops was generally managed by European concessionary companies. Industrial plantations for producing export crops were established directly by European investors, and worked by coerced or cheap labor. The African role in the commercial export crop was thus more limited. African food production remained largely a subsistence activity.

In Eastern and Southern Africa, colonial policy toward the agricultural sector was shaped by two forces: the labor requirements of mining, and the presence of large settler populations. A major thrust of colonial policy was to create labor reserves, both for mining and for working settler-operated farms. The need to feed miners--often migrants from distant areas--created a potential for a commercial market in foodstuffs, and initially this market was served by African producers. Later, however, restrictions on land ownership and production reduced the role of African producers, and commercial procurement came primarily from larger white-owned farms whose market position was supported by a wide range of government policies. The result was a dual land tenure system which had a major, negative impact on African food production.

This historical legacy affects food production today, as the trade patterns shaped by colonialism have not been fundamentally changed. Few countries have been able to significantly diversify their exports, or move away from primary export to more highly processed goods. Agricultural policies designed to support the export activities which dominated African economies at independence are still in force, and these provide much of their foreign exchange and tax revenue. African governments have given food production relatively low priority, and the historical legacy is clearly apparent in the lack of infrastructure for effectively procuring and marketing locally produced foodstuffs.

Rural conditions and government policies. Goods and services found in urban areas are not generally available in rural areas. Higher prices for agricultural products would not stimulate more production if the consumer goods which people want to buy are unavailable. In addition, more personal income would not enable rural residents to purchase important services where the infrastructure needed to provide them is not present and cannot be financed through individual expenditures. Such services include hospitals, schools, safe drinking water, electricity, and decent roads. The net effect is to make the life which might be achieved in rural areas no comparison with the life in urban areas.

Neither does the education system place much emphasis on agriculture. Information and skills which might improve agricultural practices are not taught. The general orientation of education implies that farming is not a job for educated people. Hence, upward mobility is associated with high-status non-agricultural jobs in urban areas.

The general rural conditions, coupled with the physical drudgery of farming and the dominant orientation of educational systems, have several consequences. The younger more ambitious people migrate from rural areas, leaving agriculture to older less educated people. In some countries, such migration is now creating a shortage of rural labor; farming is not considered a career, and lacks prestige. Incentives to invest in improving food production are very weak. Instead, money made in agriculture is likely to be invested in other activities --ranging from education designed to assure that some family member can move out of agriculture to the purchase of small shops or a stock of goods for petty trading.

Government policies have also contributed to the poor food production record in Sub-Saharan Africa. Virtually all governments intervene in the production and marketing of food, and relevant policies often tend to derived from urban considerations--that is, the intended beneficiaries of the policies are groups other than the producers. The dominant thrust of most food policies, at least until the early seventies, was to keep domestic food prices low to benefit urban consumers. Farm prices were often set at low levels, and this discouraged farmers from marketing more food through official channels and reduced their incentive to invest in making food production a commercial enterprise. Trade regulations were also oriented toward supplying urban consumers with cheap food, not with supporting farm income or attempting to build a strong internal marketing for domestically produced food (as is the case in many industrial countries). While government-controlled marketing institutions were designed in some cases to eliminate the unsavory actions of middlemen, they also had a strong interest in controlling procurement while keeping costs down. Compulsory procurement requirements, and attempts by some governments to operate state farms, were shaped by the need to procure for the urban market. Any policies oriented toward increasing food production and productivity would have required additional objectives and different policy instruments. These would include promoting change in agricultural practices by building effective rural institutions and adequate transportation and marketing networks, and providing appropriate social and economic incentives for their use through supportive price, credit and input policies.

In the aftermath of the food crisis of the early seventies, most African countries are attempting to become self-sufficient in key food crops. This interest has been reflected in the rhetoric and content of national plans, as well as in statements at international forums. The African members of FAO requested an assessment of what would be required to achieve food self-sufficiency by 1990. The first Organization for African Unity (OAU) economic summit, held in May 1980, placed increased food self-sufficiency high on its agenda. Many countries have responded positively to offers from FAO and the World Food Council to arrange for assistance with studies of their agricultural sector. Nevertheless, performance in the agricultural sector to date has lagged behind the rhetoric.

Improving food production will require more than organizing new production campaigns or removing past disincentives to production such as low producer prices. A whole range of policies--governing pricing, procurement, trade, storage, inputs, credit and investment--interact in important ways. If there are major inconsistencies among key aspects of these policies, the effect of one "correct" policy could be overshadowed by the negative impact of other policies, or of the constraints on policy implementation generated by the conflicting policies themselves.

The Nature of Demand

The diets of Sub-Saharan Africa are dominated by the consumption of roots, tubers, and cereals (Table 3). In virtually every country, these items in some combination provide more than 50 percent of daily calorie consumption. In the Sahel, diets are heavily cereal-based, featuring millet. In the more humid regions of West Africa, roots and tubers are important, sometimes overshadowing cereals. Some Central African countries such as Zaire have diets heavily based on cassava, with cereal consumption primarily in cities. Even in countries with relatively high

Table 3

Calories from cereals, roots, tubers and plantains, Sub-Saharan Africa

Country	Percentage of daily per capita caloric intake from: (daily average 1972-74)		
	Cereal	Roots, tubers and plantains	Total
		Percent	
Sahel:			
Cape Verde	56.3	7.0	63.3
Chad	66.0	3.4	69.4
Gambia	63.5	1.8	65.3
Mali	76.0	1.9	77.9
Mauritania	55.2	-	55.2
Niger	70.0	-	70.0
Senegal	62.6	3.9	66.5
Upper Volta	73.7	2.5	76.2
West Africa:			
Benin	41.6	32.0	76.3
Cameroon	36.6	31.4	68.0
Ghana	28.8	45.3	74.1
Guinea	59.1	20.9	80.0
Guinea-Bissau	50.5	19.4	69.9
Ivory Coast	35.7	40.6	76.3
Liberia	45.9	32.3	78.2
Nigeria	41.4	36.8	78.2
Sierra Leone	56.0	15.5	71.5
Togo	42.7	36.5	79.2
Central Africa:			
Angola	32.0	37.2	69.2
Central African Republic	22.9	52.9	75.8
Congo	12.6	65.7	78.3
Gabon	6.4	67.9	74.3
Zaire	16.1	60.8	76.9
East Africa			
Burundi	26.5	43.6	70.1
Ethiopia	70.6	3.0	73.0
Kenya	57.3	11.6	68.9
Rwanda 1/	18.5	56.5	75.0
Somalia	55.0	2.1	57.1
Sudan	47.3	10.6	57.9
Tanzania	33.9	30.3	64.2
Uganda 2/	29.8	31.5	61.3
Southern Africa:			
Botswana	59.6	-	59.6
Lesotho	53.2	-	53.2
Madagascar	64.4	16.6	81.0
Malawi	76.2	1.9	78.1
Mozambique	35.3	38.9	74.15
Namibia	46.1	14.4	60.5
Swaziland	58.1	2.3	60.4
Zambia	67.9	5.5	73.4
Zimbabwe	67.8	5.0	73.28

- = Value less than one percent

1/ Plaintains make up 30% of caloric intake.

2/ Plaintains make up 15% of caloric intake.

Source: Food and Agriculture Organization, Provisional Food Balance Sheets, 1972-74 Average.

concentrations of nomadic people (for example, Somalia) or important cattle operations (for example, Botswana), the bulk of the national diet is still derived from cereals amd/or roots and tubers. There are clear urban-rural differences in diet. Wheat as a complementary food (in the form of bread), and rice as a staple, are becoming increasingly important in urban areas, often displacing the traditional food.

Conclusions

Sub-Saharan Africa's precarious food balance stems from a combination of demand and supply factors. Urbanization and income growth have interacted with one another to create a structure of demand in urban areas that is difficult to match from domestic production, resulting in imports on an increasingly costly scale. While many African governments have spoken hopefully of reducing their food imports, particularly of wheat and rice, there is obviously a limited potential for doing so without risking political retribution. In this situation, governments have two other options: first, attempting to shift tastes and preferences of urban consumers away from imported foods and in the direction of domestically-produced foods through information campaigns and other measures; and second, attempting to make domestically-produced foods more palatable and convenient to urban dwellers through improved processing techniques. The first of these options would appear to be more applicable in the Sahel and East Africa, where strong tastes for imported food staples have developed. The second would appear to apply particularly to RTP (roots, tubers and plantains) in West Africa, for which our research indicates that an income preference exists.

Despite rural-urban migration, the increase of urban demand for food from domestic rural producers has been very weak because governments have hitherto been able to rely on imports to fill major urban demand from cities on coasts and waterways. Thus, the rural producing areas have been effectively isolated from linkage effects that in other parts of the world have resulted in self-sustaining agricultural development. So the subsistence sector, which accounts for the great bulk of food production in most parts of Africa, remains largely a closed one, responding mainly to the food needs of immediate local populations. Cash crops (for export) and off-farm labor earnings can provide ready cash as needed. Current methods leave farmers with a high degree of vulnerability to natural hazards from year to year. Moreover, the difficulties of transportation almost everywhere, together with the concentration of food production in brief growing periods in the semi-arid areas, result in wide seasonal price fluctuations in local markets and give rise to profit-making by traders and hoarders.

Citing the undesirable effects of speculation in the food trade, governments have intervened in staple food markets by setting procurement prices, attempting to enforce monopoly procurement, and creating barriers to the free movement of foods. The result has frequently been to aggravate regional imbalances of food, and to exaggerate price instability. Costs to governments in these operations are high. Costs to producers are high as well; many producers are selling at harvest time only in order to pay off debts, in the expectation of buying back later in the year so as to get through the "hungry" season.

This situation will have to be drastically changed if domestic food production is to be expected to play a larger role in meeting aggregate food needs of African countries. The generally low levels of productivity must be raised; that this is possible is shown by demonstrations of a high yield potential from additional inputs in the agricultural experiment stations.

Where the transportation infrastructure is at its most rudimentary, or where it has been allowed to deteriorate since independence as in the Central African countries, producers in aggregate have not exhibited price responsiveness. Here, it is obvious that marketing costs are exorbitant, and government efforts to raise producer prices will be ineffective as a means of stimulating output except when combined with other costly investments from national budgets. On the other hand, in countries with relatively well integrated marketing networks, producers of staples for which there exists a strong demand in urban areas (provincial towns as well as capitals), like rice in West Africa and in Madagascar and Mozambique, have been shown to be price-responsive. Consequently, government investments in irrigation infrastructure, or reduction of the fertilizer-rice price ratio, can bring about large changes in output--up to a doubling of output.

Assuming the existence of appropriate price incentives to producers, however, the African countries would still lack the physical and human resources to produce sufficient additional quantities of staples to replace the totality of their imports, even if maize, millet, and other African crops were completely substitutable for imported rice and wheat. An enormous expansion of cropped area would be required to fill the import gap under present conditions of production. And assuming that yield-increasing packages of new technology were available, the financial resources necessary to sustain such an increase in production would seem to be lacking--except possibly in Nigeria. In sum, some portion of the import gap can possibly be closed in the coming decade, but not the whole gap.

In this situation, no magic solution exists. Upgrading the productivity of the large-farming sector and raising that of the subsistence sector both pose problems to government. Any increase in productivity implies a heavier use of fertilizer, pesticides, and other purchased inputs; this runs the risk of creating a new dependence on foreign sources of supply to replace an old one. The logistical problems of delivering inputs to the subsistence sector in African countries are obviously much greater than delivering them to a relatively few large farms. On the other hand, the environmental consequences of clearing land for large farms in the present condition of limited knowledge about effects on tropical soils may be costly as well. Moreover, government investments in large-scale farming in an effort to bypass the subsistence sector and achieve high growth rates of food production would inevitably leave in place an impoverished rural population outside the big farms, who would produce a never-ending stream of migrants to the cities.

Narrowing the food gap will require a combination of price incentives to producers and a workable procurement system with massive government investments in productive infrastructure, training and extension services, and an upgrading of research programs. Our research indicates that the priorities that should be given these investments would vary from region to region in accordance with resource endowments and agricultural structure.

Improving the productivity of resources in the subsistence sector implies a transformation of the subsistence sector itself, since labor and land, the main productive resources, are deeply embedded in the socio-economic framework in which production takes place. The transformation will necessarily be in the direction of a much more heavily commercialized structure. This must be initiated in an environment where markets are far from perfect, uncertainty prevails, and the prices farmers receive for their product have been notoriously low compared to prices at the next point of sale. Indeed, the tendency to revert to local autarky appears today whenever marketing links are disrupted by political unrest or sharp reversals of government agricultural policies. Such a transformation, however, can be done in several ways. In East Africa higher productivity of food production per hectare could allow farmers to allocate more land to the production of traditional cash crops, which would be desirable in situations where government policymakers see income generation in rural areas to be a useful goal in itself. A similar change in West Africa could well take the form of more land allocated to production of maize, a non-traditional cash crop in much of the region, for commercial sale. And in the Sahel, it might allow marginal land to be taken out of production altogether, or fallow periods to be lengthened.

The introduction of new technologies is a major means of raising the productivity of resources in food production. Initiating the research work required for the development of such new technologies should rank high on the list of priorities in all regions. Careful thought needs to be given to the design of research programs, however, so that they do not lead to unfulfilled promises--as they have in the past. The design needs to take into account the structure of African agriculture, notably its relative factor endowments, as well as the limiting characteristics of soils and crops. The technology needs to be relatively self-contained, and not dependent on a heavy supporting infrastructure. New crop varieties whose performance improvement consists in reducing the variability of yields could have a significant impact on production. Better linkage between information on consumer preferences and research on new crop varieties is important; there may be ways to ease the tendency of people with higher incomes to shift away from traditional staples.

Bringing about the transition to a more commercialized system of food production in a way that will avoid creation of large unmarketable surpluses and other such man-made problems hinges greatly on the timing of government policies, and on the skill with which their implementation is handled. Relative prices may become more important as markets improve, as will the ability of marketing systems to handle a wide range of crops. This implies close coordination of storage and trade policies with production policies. Flexibility in input deliveries will certainly be important. Input subsidies may have a role to play at the early stage of the transition in shaping production patterns, generating rural income, and creating effective farmer demand. This means that input subsidies should be used by African governments in a different way than they are used at present, which is to increase production of export crops. Instead, they should be used to capture linkages within the rural production sector; given the present high costs of transportation and marketing, what may appear to be a high operating cost of subsidy to create food supply may actually be a net economic benefit by its stimulative effect. At a later stage of the transition the input subsidies, which are relatively expensive for governments to sustain, may be reduced or dropped altogether.

The development of agricultural processing industries is another way of generating income in rural areas and creating linkages to national economies which do not exist at present. The successful local processing of roots and tubers in Central African countries, for instance, would represent a real gain in transportation costs, and would meet a demand for a more convenient food in urban areas.

The following specific conclusions have been drawn from the analysis:

1. In the near term, the coordination of government policies in food production, marketing, and trade offers the best hope of meeting food needs in Sub-Saharan Africa. The timing of the application of these different policies will need to vary from one country to another. The extent to which realization of production potential depends on improvement in one factor (e.g., inputs in Kenya) will also vary among countries. A policy success in one country may have repercussions, beneficial or harmful, in neighboring countries.

2. Shifting urban consumer tastes, and introducing new processing technologies for foods to make them more palatable and convenient, afford some scope for replacing a portion of imports with domestic production. Programs along these lines will help toward self-sufficiency in food for some countries and generate employment in all countries. The servicing of urban markets can create valuable linkages to rural areas where none exist at present.

3. The transformation of the subsistence sector in ways that raise living standards and respect social values must be a long-term goal of African governments. Such a transformation must be based on improving productivity in food production, which can be expected to lead either directly or indirectly to higher rural income, and decreased drudgery of farmwork. Rural purchasing power in turn could induce an infusion of consumer goods into rural areas which would act as a further stimulus to higher productivity, breaking the isolation of the subsistence sector.

4. We have taken a time frame of 10 years in the present study. In the longer term, a solution of the food problem in Sub-Saharan Africa probably depends on basic investments in education and research. Policies and programs suggested above will be self-limiting unless they are backed up by appropriate local institutions. Educational institutions must develop ways of raising the presently low status of agriculture so as to upgrade the quality of people and methods in food production. Research institutions must find the answers to basic unanswered questions about the capability of soils and crops to sustain a highly productive agriculture. While such investments seem to have little short run payoff, they are essential for longer run progress.

[Extracted from Chapters 1 and 6 and Executive Summary of Food Problems and Prospects in Sub-Saharan Africa: The Decade of the 1980s, Foreign Agriculture Research Report No. 166, U.S. Department of Agriculture, August 1981.]

INDEX - VOLUME XIX, 1981

Subjects

Afghanistan
  1:83-97

Africa
  Development Strategy
    4:95-117
  Food Problems
    4:118-132

Agriculture
  in Africa
    4:118-32
  Plant Growth Frontiers
    4:3-20
  Pricing Policy
    3:25-54
  Research, Farmer-Centered
    3:3-22

Aid Strategy
  to Combat Poverty
    3:109-124
  Trends in
    3:125-128

Community Participation
  in Family Planning
    4:35-45
  in Health
    1:83-97, 107-114
  in Nutrition
    2:69-74
  in Water Projects
    4:74-85

Disaster Assistance
  Earthquakes
    2:110-118
  Food Relief
    2:119-128
  Planning for
    2:93-97
  Shelter
    2:98-109

Education, Primary
  and Development
    1:3-13
  Broadcasting, Use of
    1:14-24
  Experimental Programs
    1:38-42
  Rural Vocational Schools
    1:25-37

Egypt
  3:37-45

Energy Choices
  Cultural Constraints
    3:98-106
  Fuelwood
    3:71-81
  Peat
    3:91-97
  Policy
    3:57-70
  Woodstoves
    3:82-90

Food
  Africa
    4:118-132
  Child Nutrition
    2:29-74
  Relief
    2:119-128
  Rice Distribution
    3:46-54

Guatemala
  1:38-42

Health
  Child Nutrition
    2:29-74
  Community Health Workers
    1:79-128
  Health Insurance (Java)
    1:107-114
  Primary Health Care
    1:79-82

India
  1:38-42

Subject Index - Cont'd.

Indonesia
  1:38-42, 107-114

Industrialization Trends
  2:3-26

Kenya
  1:98-106

Mexico
  1:66-76

Midwifery
  1:115-128

Newly Industrializing Countries (NICs)
  Argentina, Brazil, Hong Kong, India, Mexico, South Korea Singapore, Taiwan
    2:3-26

Nutrition-Children
  Community Awareness
    2:69-74
  Fats and Oils
    2:41-48
  Green Leaves
    2:49-58
  Malnutrition
    2:29-40
  Program for
    2:59-68

Organization for Development
  Management of
    1:45-55
  Negotiating Model
    1:66-76
  Weakness of Western Methods
    1:56-65

Peat
  3:91-97

Pedal Power
  2:77-90

Philippines
  1:38-42

Plant Growth Frontiers
  Fertilizer Manufacture
    4:4-15
  New Chemicals
    4:16-20
  Nitrogen Fixation
    4:4-15

Population Trends
  Contraceptive Research
    4:43-53
  Men and Family Planning
    4:35-42
  Mortality Trends
    4:54-64
  Overview
    4:23-34

Pricing Policy, Agricultural
  in Developing Countries
    3:25-36
  in Egypt
    3:37-45
  in Sri Lanka
    3:46-54

Research, Agricultural
  Farmer-Centered
    3:3-22
  Plant Growth Frontiers
    4:3-20

Sri Lanka
  3:46-54

Tanzania
  1:98-106

Upper Volta
  1:25-37

Water, Clean
  Supply and Maintenance
    4:74-85
  U.N. Decade
    4:66-73
  Well-Building
    4:86-92

Wood
  as Fuel
    3:71-81
  Woodstoves
    3:82-90

INDEX - VOLUME XIX, 1981

Authors

Acharya, Shankar N.
4:95-117
Agarwal, Anil
4:74-85
Agriculture, U.S. Department of
4:118-132
Atkinson, Linda, S. Bruce Shearer,
Oscar Harkavy and Richard Lincoln
4:43-53
Blundell, D. J.
2:110-118
Brace, Judith and Barbara O'Grady
1:38-42
Brown, Gilbert T.
3:25-36
Cameron, Margaret and
Yngve Hofvander
2:29-40; 2:59-68
Cecelski, Elizabeth, Joy Dunkerley
and William Ramsay
3:98-106
Chambers, Robert
3:3-12
Chandrasekara, Indrani Sri
and James Gavan
3:46-54
Christie, Linda J., Mayling
Simpson-Hebert, Phyllis Piotrow
and Janelle Streich
1:115-128
Cross, Peter N. and
Steven L. Solter
1:83-97
Crosswell, Michael
3:109-124
Cuddihy, William
3:37-45
Davis, Ian
2:98-109
Dearden, Claire, Pat Harman
and David Morley
2:41-48
Donald, Gordon Jr.
3:125-128; 4:3
Dunkerley, Joy, Elizabeth
Cecelski and William Ramsay
3:98-106
Earthscan
4:67-73
Foote, Dennis, Robert Hornik,
Barbara Searle and Jeanne
Moulton
1:14-24
Franda, Marcus
4:4-11
Gavan, James and Indrani
Sri Chandrasekara
3:46-54
Grubben, G.J.H. and
Oomen, H.A.P.C.
2:49-58
Gwatkin, Davidson R.
4:54-64
Harkavy, Oscar, *et al.*
4:43-53
Harman, Pat, Claire Dearden
and David Morley
2:41-48
Hendrata, Lukas
1:107-114
Hoffmann, R. Thomas and
Brian Johnson
3:57-70
Hofvander, Yngve and Margaret
Cameron
2:29-40; 2:59-68
Hornik, Robert, Barbara Searle,
Dennis Foote and Jeanne
Moulton
1:14-24
Institut d'Etude du Développement
1:25-37
Johnson, Brian and R. Thomas
Hoffmann
3:57-70
Korten, David C.
1:45-55

Author Index - Cont'd.

Kovaly, Kenneth A.
  4:12-15
Lincoln, Richard, et al.
  4:43-53
Maugh, Thomas H. II
  4:16-20
Mauldin, W. Parker
  4:23-34
Miller, Eric J.
  1:66-76
Miller, Norman N.
  1:98-106
Moris, Jon R.
  1:56-65
Morley, David, Claire Dearden and Pat Harman
  2:41-48
Moscardi, Edgardo and Donald Winkelmann
  3:13-22
Moulton, Jeanne, Robert Hornik, Barbara Searle and Dennis Foote
  1:14-24
National Academy of Sciences (U.S.) - National Research Council
  3:71-81; 3:82-90
National Planning Association
  2:3-26
O'Grady, Barbara and Judith Brace
  1:38-42
Oomen, H.A.P.C. and G.J.H. Grubben
  2:49-58
Piotrow, Phyllis T., Mayling Simpson-Hebert, Linda J. Christie and Janelle Streich
  1:115-128
Punwani, D.V.
  3:91-97
Ramsay, William, Elizabeth Cecelski and Joy Dunkerley
  3:98-106
Save the Children Federation, Inc.
  2:69-74
Schearer, S. Bruce, et al.
  4:43-53
Searle, Barbara, Robert Hornik, Dennis Foote and Jeanne Moulton
  1:14-24
Simpson-Hebert, Mayling, Phyllis T. Piotrow, Linda J. Christie and Janelle Streich
  1:115-128
Solter, Steven L. and Peter N. Cross
  1:83-97
Stokes, Bruce
  4:35-42
Streich, Janelle, Mayling Simpson-Hebert, Phyllis T. Piotrow and Linda J. Christie
  1:115-128
Volunteers in Technical Assistance (VITA)
  3:82-90
Wallerstein, Mitchel B.
  2:119-128
Watt, S. B. and W. E. Wood
  4:86-92
Whiteman, Michael R.
  2:83-90; 2:93-97; 4:3
Wilson, Stuart S.
  2:77-82
Winkelmann, Donald and Edgardo Moscardi
  3:13-22
Wood, W. E. and S. B. Watt
  4:86-92
World Bank Staff
  1:79-82; 1:3-13

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